COLONY AND PROTECTORATE OF KENYA

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Vol. II—Record of Investigations

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Stored Products

The Pest Infestation of Stored Products (Interdepartmental) Committee had five meetings during the year. The chief subjects discussed were the use of D.D.T., B.H.C., and other poisonous insecticides in foodstuffs. It was decided to allow B.H.C. up to 1 part per million which is sufficient for effective insect control and well within the safety limit. A study of African storage methods was approved, to be carried out when time permits. Experiments with methyl bromide were approved to be started when the necessary equipment can be obtained. Experiments on the control of weevil in cribs were discussed and it was decided that such experiments must be accorded high priority and be carried out as soon as possible. Maize cribs have now been built for this purpose.

The future plans aim to investigate a large range of pest infestation matters and the implementation of such plans depends on the obtaining of further staff.

The experimental work in progress is reported on by Mr. S. Kockum as follows:—

1. An experiment was completed using a randomized block of 48 bags of slightly infested maize. Treatments were with pyrethrum, pyrethrum with diatomite (pysil) and diatomite. In this experiment pyrethrum alone did not offer any protection while diatomite and pyrethrum with diatomite gave about equal protection.

2. An experiment with the same materials was carried out with fumigated maize and the results though less marked were similar to those in the previous experiment.

3. A further experiment, still in progress, was planned to study the effects of pyrethrum, pyrethrum with diatomite (pysil) and diatomite at high humidity. (65 per cent to 70 per cent R.H.) Sixteen bags of maize were placed in randomized positions after mixing and fumigation and these were spread on the floor in a single layer and weevils were introduced. Monthly counts of the insects showed a rapid increase of *Calandra oryzae* in the untreated bags up to a maximum of seven months. A sudden drop in the numbers then occurred and a steady decrease followed. Large numbers of parasitic hymenoptera (*Aplastomorpha calandrae*) occurred in the room and these are considered to be responsible for the fall in the numbers of the weevils in the control bags. Bags treated with pyrethrum showed no living Calandra for five months. Afterwards they were found in the bags and increased so that 13 months after beginning the experiment they exceeded those found in untreated maize. In the pysil and diatomite bags they were found after two months and increased slowly after five months.

Diatomite was more effective than pysil. Counts of damaged grains after 12 months showed untreated maize 97 per cent, pyrethrum treated 39 per cent, pysil treated 41 per cent, and diatomite treated 17 per cent. Initial damage was 4.6 per cent.

4. A randomized block experiment using bags of maize in a single layer was used to test effects of pyrethrum, pyrethrum with piperonylbutoxide prepared in the U.S.A. and also locally, benzene hexachloride at 1 part per million, talc and diatomite. The experiment is still in progress in a heavily infested store. The untreated maize showed the same effect as in 3 above, i.e. a maximum infestation at five months followed by a fairly rapid drop. Bags treated with talc showed a lower peak in numbers while with diatomite a still lower peak was reached a month later. The two pyrethrum with piperonylbutoxide treatments showed almost complete protection for five months followed by slowly rising insect numbers. Pyrethrum and benzene hexachloride in this experiment still showed complete protection after ten months.

5. Small-scale experiments with maize, treated with inert dusts have confirmed that weevils have difficulty in moving upwards through maize so treated. Further tests are being planned along these lines.

The varying results with pyrethrum have posed difficult questions which have not yet been answered but investigations into the effect of pyrethrum at different levels of relative humidity and moisture content are in progress.

General Investigations

Mr. J. F. Graham, Entomologist, was centred mainly at the Scott Agricultural Laboratories with spells on locust work and in Mauritius. He reports as follows:—

Introduction of Scoliid Wasps for Biological Control

Opportunity was taken to collect Scoliids in Mauritius where introductions have been made in the past to control the grubs of *Clemora smithi*. Grubs of related Melolonthid species of similar size are pests in Kenya, notably in the Trans Nzoia, so the same wasps may be well able to parasite them also.

From June to the end of the year the species most readily available in Mauritius was *Campsomeris erythrogaster*. Smaller numbers of *Scolia carnifex*, *Tiphia parallela* and *C. phalerata* were also obtained. *Campsomeris lachesis* were fairly common, but already occur in East Africa and so were not brought to Kenya for liberation. Collections of wasps were made and sent by air to Nairobi up till 22nd November, this being continued after my departure by entomologists of the Mauritius Department of Agriculture.

The first consignments travelled badly but different packing materials were tried and it was eventually found that those packed in damp moss arrived in very good condition. On arrival in Nairobi a quarantine had to be imposed to obviate the risk of introducing secondary parasites. The wasps are parasitized by Conopid flies and these probably kill a high proportion in Mauritius. Fortunately, such affected wasps die soon after capture—usually within a fortnight and never more than 17 days in Nairobi. Quarantine period imposed, namely 28 days, thus allows a good margin of safety.

In addition to the wasps their favourite food plant, *Eupatorium pallescens*, was also introduced from Mauritius. This plant is difficult to grow from seed or cuttings, and so is not likely to spread and become a weed. It may be a useful plant for bee-keepers.

Twenty-five rooted cuttings were planted in the Kitale district and 25 at Nairobi at the Scott Agricultural Laboratories where all but one were successfully transplanted.

Liberations of female wasps were as follows: —

Kitale Area—	
Campsomeris erythrogaster	559
Campsomeris phalerata	16
Nairobi—	
Tiphia parallela	1
C. erythrogaster	80
C. phalerata	1

Recoveries of these parasitic wasps may not be made for several years and even if their introduction is successful a high degree of control is not probable. Nonetheless by reducing the numbers of the grubs they may result in an increase in crop. Scoliids occurring locally were studied but none of a size likely to attack *Schizonycha* was found, nor are any local Scoliids known to parasitize this chafer.

An investigation of attack by various wood borers on Whistling Thorn was made in the Ngobit area, and rearing of the adult beetles is awaited.

Termite-proofing materials are being tested for the Public Works Department Materials Branch. So far none has proved termite proof.

General Insecticide Work

Mr. P. T. Walker, Entomologist, an officer of Colonial Insecticide Research, was posted to work in the Entomological Section, on plans agreed by the Specialist Insecticide and Entomological Committee, dealing with insecticides for the control of crop pests. He reports as follows: —

"An essential part of the time at the Scott Agricultural Laboratories has been spent on the development of stocks of insects for insecticide testing, and of these establishment of scale insects on citrus trees has proved the most difficult. An infestation of these on young rough lemon seedlings is now being developed by removing Red Scale crawlers from mature scales under the microscope and placing them directly on the leaves of the seedlings. Other insects being bred for testing are Aphids on beans, and the Sweet Potato Weevil.

Laboratory testing will be speeded up on the arrival of a 'Potter' spray tower from England. A dusting technique in use at the Laboratories has been used for testing insecticides against a species of *Epilachna* which causes damage to wheat. A 2 per cent Parathion dust was found the most effective at 2.97 mgm./sq.ft. of Parathion or 14 lb. per acre giving 100 per cent kill. Ninety-six per cent mortality was obtained at 0.98 mgm./sq.ft. active agent or 5 lb. per acre after 16 hours. D.D.T. as 5 per cent dust gave 100 per cent kill after three days at 1.66 mgm./active ingredient per sq.ft. or 8 lb. per acre. Benzene hexachloride, in the form of Agrocide 3, at 17 lb./acre (1.04 mgm./sq.ft. gamma B.H.C.) gave 75 per cent kill after four days and 100 per cent kill after eight days. These materials offer a promising means of control of the beetle in the field.

White grubs or larvæ of various Chafer beetles were tested in small replicated box tests with insecticides mixed with soil. Due to a high control mortality the results were less significant than was expected, but Aldrin (as 2½ per cent dust) at 8 oz./acre of active ingredient gave 100 per cent kill after four weeks, and at 4 oz./acre 100 per cent kill after five weeks. Parathion was highly effective at 8 and 4 oz./acre active ingredient after six or seven weeks. D.D.T. and gamma B.H.C. were less effective under the conditions of the experiment. It is intended to incorporate these materials in a trial at Kitale during the next planting season.

Citrus Scale Insects.—A citrus orchard with some fairly heavy infestations of *Aspidiotus hederæ* was sprayed in August, October and February with two concentrations of Parathion 15 per cent wettable powder, 0.03 per cent and 0.07 per cent active ingredient. The general condition of these trees was improved, and while some new settlement of crawlers took place on those sprayed with 0.03 per cent, none or very few were found on those sprayed with 0.07 per cent. *Aonidiella aurantii* (Red Scale) was much reduced. In general, either more frequent applications or better timing of sprays are required, or applications of higher pressure than 40–70 lb./sq.in. of a Four Oaks sprayer is needed. Further trials are planned to follow more closely the effect of Parathion and compare it with the proprietary sprays of the summer oil type.

A peach orchard which was expected to be heavily attacked by *Ceratitis capitata* and other fruit flies was sprayed with nicotine and benzene hexachloride sprays as a bait. This is mentioned elsewhere."

Systematic Study of Certain Economic Families

Mr. G. de Lotto continued to work on the collections and to increase our knowledge of several important economic groups. He has identified a large number of insects intercepted on imported plant material. He has done identification work on Coccidæ for other sections of the department and for other East African territories. This work is of basic importance to other workers in the section. Mr. de Lotto reports as follows:—

"During the past year surveys have been carried out in the Nairobi area on the Diptera Trypetidæ and the other Hemiptera Aleurodidæ, Aphididæ and Coccidæ.

The Coccid material collected consisted of over 350 batches including some sent in from other localities.

A great deal of time has been spent on mounting and studying this material which represents about 100 species. While this number may be only a small part of the Coccid fauna of Kenya, among the species mentioned several are of great entomological and agricultural interest.

About 60 species have so far been identified and of these the following are new records for the country:—

1. *Aonidiella replicata* (Lind)
2. *Aspidiotus vernoniae* Hall
3. *Asterolecanium miliaris robustum* Green
4. *Coccus acuminatus* (Sign)
5. *Coccus acutissimus* (Green)
6. *Coccus bicruciatus* (Green)
7. *Eucalymnatus tessellatus* (Sign)
8. *Africaspis chionaspiformis* (Newst)
9. *Aonidomytilus albus* (Ckll)
10. *Howardia biclavis* (Comst)
11. *Abgrallaspis cyanophylli* (Sign)
12. *Abgrallaspis palmae* (Morg)
13. *Lindingaspis opima* (Silv)
14. *Pseudaonidia trilobitiformis* (Green)
15. *Selenaspidus silvaticus* Lind
16. *Furcaspis capensis* (Walk)
17. *Varicaspis fiorineides* (Newst)

Another 20 species are under study, whilst about 15 species are apparently new and will be described in the near future.

A list of all species of scale insects previously described or recorded from East Africa (Kenya, Tanganyika and Uganda) has been started. This list which is based mostly on systematic works, so far includes 219 species on about 700 host plants.

If possible in future, the list will be extended to the species of the whole Ethiopian region."

Pests of African Crops

Mr. G. M. Lavers, Senior Assistant Agricultural Officer, worked on the pests of crops in African areas, the work was of a preliminary nature but shows promise of useful practical results in control measures especially against stalk borer of maize and Sweet Potato Weevils. Mr. Lavers reports as follows:—

"Two different Curculionids (*Alcidodes* spp.) attacking Sweet Potato (*Ipomea batatas*) in the Kiambu district were investigated. These two species of weevil did considerable damage throughout the area during the dry months January to March. By June they had mostly disappeared and were not of any consequence for the rest of the year.

Also during the dry weather *Plutella maculipennis* was general throughout the district on Brassica sp. Pupæ were collected in large numbers and several species of parasites were obtained.

Some pests on Pigeon Pea (*Cajanus cajan*) which again were found in the district were investigated. Three species of Lepidoptera were found breeding in the seeds and parasites were reared from all.

Work has been continued on the maize stalk borer (*Busseola fusca*) including a survey in the Kiambu district. This showed that in general the infestation is rather less than that found in the main European maize-growing areas. During this work a Pyralid moth (*Chilo suppressalis*) was discovered in maize.

Corn Ear Worm (*Heliothis armigera*) was found now and again during the investigations on maize, and was found once attacking tomatoes.

Stalk borer (*Busseola fusca*) was also investigated in Sorghum. The problem of how best to apply insecticides to this crop is to be investigated.

In December I was posted to Kitale to supervise the investigation of losses through pests to maize in the crib in the Trans Nzoia district.

In addition, as occasion offered, experiments with insecticides were carried out at the Scott Agricultural Laboratories and in the Kiambu district."

Other Investigations

(*a*) Maize Stalk Borer (*Busseola fusca*)

In spite of a closed season for planting maize from June to February in most areas and use of the effective insecticidal dressings of 1 per cent D.D.T. dust, or 1:600 Derrisol solution by many farmers maize stalk borer infestation was heavy.

Figures for the Rift Valley Province were over 20 per cent infestation and up to 70 per cent of stalks bored in untreated maize. One farmer had damage resulting in a crop not worth the expense of harvesting.

The rate of parasitism of the caterpillars by *Apanteles sesamiæ* was high in some areas but it did not check their numbers effectively.

(*b*) Black Wheat Beetle (*Heteronychus consimilis*)

This beetle was studied by Mr. Goddard at Ol Kalou. A series of insecticide experiments were laid down. These gave very good results. The help of Mr. Schouten in these experiments is acknowledged with thanks.

Soil and seed dressings were tried out on one-tenth-acre strips planted with wheat and counts of dead beetles were made. Both these and the weight of grain harvested show that two treatments were outstandingly effective.

One of these was "Mergamma" A, applied at the rate of 10 oz. to 200 lb. of seed wheat (3¼ oz. acre) while the other was 18 lb. of 2½ per cent Aldrin dust applied through the fertilizer attachment to the wheat drill. (7.2 oz. of technical Aldrin per acre).

(*c*) Jacaranda Bug (*Orthezia insignis*)

This pest has been widely reported, particularly by gardeners wishing to obtain Coccinellid beetles to control it by biological means. As no insecticide suitable for the use by the general public is available against it the number of requests for predatory ladybirds was far in excess of what was expected. The breeding of these ladybirds is described elsewhere.

Orthezia insignis was reported on the following plants:—

Jacaranda, Verbena, Lantana, Petrea, Cuphea, Eranthemum, Roses, Gaillardia, Salvia, Nandi Flame, Barberton Daisy, Cat Mint, Coreopsis, Pansy, Evening Primrose, Agathea, Bignonia, Dyschoriste, Thunbergia, Veronica, Cestrum, Markhamia hildebrandtii, Bougainvillea, Tecoma, Mesembryanthemum, Ceratostigma, Kei Apple, and Alyssum;

and from the following places—

Nairobi, Ruiru, Nanyuki, Kitale, Kiambu, Karatina, Voi, Embu, Kerugoya, Ngong, Njoro, Fort Hall, Chogoria, Meru, Kisumu, Makuyu.

(*d*) Injurious Grasshoppers (Acrididæ)

Grasshoppers, at first suspected of being locusts, were reported from the Nakuru area in June. Investigation revealed densities of three to four grasshoppers per square yard. These were medium to large species—*Gastrimargus brevipes*, *Cataloipus* sp. *Crytacanthacris tatarica* and *Caloptenopsis* sp. Small numbers of other grasshoppers were also present. Damage to grazing was appreciable, the grass being eaten off short in some places. Marabou storks were said to have reduced the infestation at Soysambu. A short paper on these was prepared for publication.

(*e*) Injurious Ladybirds (*Epilachna* sp. Coccinellidæ)

A heavy infestation of a species of *Epilachna* was visited in the Nakuru area. The beetle was particularly numerous on oats and barley and was also damaging maize and potatoes. On barley up to 45 were taken in a single sweep of a net.

Laboratory tests by P. T. Walker showed that D.D.T., benzene hexachloride and Parathion gave effective kills. Parathion dusts at 2 per cent and 0.5 per cent were most effective but 5 per cent D.D.T. gave a satisfactory kill after three days. Agrocide 3 was less effective. For field use 5 per cent D.D.T. at 20–40 lb./acre is suggested.

(*f*) Fruit Flies (Trypetidæ)

Fruit flies were reported from cucumbers, loofahs, oranges and coffee, as well as from the heads of various flowers. Field tests were carried out with poisonous sprays on peach trees at Ngong. These were made up of nicotine sulphate or Agrocide wettable powder in a solution of molasses. The molasses was used as a substitute for sugar. Results obtained were inconclusive owing to the lightness of the infestation which occurred, but there is no reason to believe that the baits were ineffective. With molasses as the attractant care must, however, be taken to avoid spraying the fruit as a brown mould may develop where the spray falls.

(*g*) Dusty Ground Beetle (*Dasus simplex*, Tenebrionidæ)

This was reported as damaging New Zealand flax at Timau but widespread damage was not reported this year. The use of seed dressings such as "Mergamma" A or even Agrocide 7 protects newly planted grain and should prevent replanting which formerly was often necessary.

(*h*) Cassava Scale (*Aonidimytilus albus* Coccidæ)

This was recorded from the Voi district for the first time and it continued to be a serious pest in Central Nyanza. Infested plants in Nyanza were at first burnt, but disease spread widely in spite of this, and chemical control was considered necessary. White oil or kerosene emulsions are recommended since the more effective new insecticides are considered too dangerous for application in the conditions.

(*i*) Rhinoceros Beetle (*Oryctes monoceros*, Dynastidæ)

Great progress has been made at Gazi in clearing the plantations of dead and dying trees which it is reported has already helped in reducing the pest. Breeding of this species in Dom palm logs was demonstrated by Mr. Sethi. This may not be an important alternative host but this needs investigation. The use of pit-traps containing suitable breeding materials, such as cow dung and rotten logs was begun at Gazi and large numbers of larvæ were found in them. This is considered a useful auxiliary method of control.

(*j*) Tomato Worm or Maize Earworm (*Heliothis armigera*, Noctuidæ)

Serious damage to maize was reported from the Lugari area where nearly every cob was affected in certain fields. The caterpillar was also reported from tomatoes from Thika and Shelley Beach. Damage to maize is often followed by the entry of other organisms, both insects and fungi and is all the more serious as there is no insecticide which can be applied cheaply and effectively. Infested tomatoes at Thika were treated by P. T. Walker, with D.D.T. sprays. Derris, Derrisol and Agrocide 3 and indications were that 0.05 per cent D.D.T. spray was the most effective.

(*k*) Sweet Potato Weevils (*Cylas puncticollis*, *Alcidodes dentipes* and *Alcidodes clathratus*, Curculionidæ)

Heavy damage by *Cylas puncticollis* was reported from the coast at Matuga. It occurred also at Kikuyu together with *Alcidodes*. An area of sweet potatoes was established at the laboratories and work on the life histories of these pests was carried out by Mr. Lavers. An important measure to control the spread and lessen the general severity of these pests is to ensure that only uninfested planting material is used.

(*l*) Banana Weevil (*Cosmopolites sordidus*, Curculionidæ)

This continued to infest plants in parts of the coast and Nyanza but was not reported during the year.

(*m*) Fruit-sucking Moths

These insects were not reported during the year and the damage was not so marked as usual in the Molo area.

(*n*) Flax Caterpillar (*Phytometra orichalcea*, Noctuidæ)

A heavy attack on kale was effectively treated by a D.D.T. spray of 1 lb. of 50 per cent wettable powder in 100 gallons of water. This insect was also reported damaging maize at Molo and Kitale.

(*o*) Coreid Bugs on Coco-nuts (*Theraptus* sp., Coreidæ)

Following the work of Mr. M. J. Way in Zanzibar, damage to coco-nuts resulting in immature nut fall was observed to be occurring on a considerable

scale in January, and specimens of nymphal Coreid bugs were found. It was not until September that opportunity occurred to make a study of this bug and its effects. The insect was reared to adult stage in organdie sleeves placed over the inflorescences and proved to be a different species of *Theraptus* from that in Zanzibar, as we were informed by the Commonwealth Institute of Entomology. The bug is clearly an important factor in reducing coco-nut yields.

Miscellaneous Pests

Plutella maculipennis	Rape	Nairobi
Ceratitis capitata	Coffee	Nairobi
Sesamia sp.	Sorghum	Nairobi
Melanagromyza phaseoli	Beans	Nairobi and Kericho
Xanthogramma aegyptium	Sorghum	Nairobi
Acherontia atropos	Coffee	Nairobi
Dasychira thysanoessa	Fig	Nairobi
Aonidiella aurantii	Citrus	Songhor
Toxopterum aurantii	Citrus	Songhor
Trioza merwei	Citrus	Songhor
Gnathocerus cornutus	Cassava	Nairobi
Calandra oryzae	Cassava	Nairobi
Tribolium sp.	Cassava	Nairobi
Laemophloeus sp.	Cassava	Nairobi
Thrips tabaci	Onions	Nairobi
Icerya purchasi	Roses	Molo
Steatococcus sp.	Figs	Sotik
Theraptus sp.	Coco-nut	Gazi
Lixus sp.	Pyrethrum	Ol Joro Orok
Epimadyza nigra	Gladiolus	Ruiru and Nyeri
Apate sp.	Peach	Kitale
Papilio sp.	Lime	Nairobi
Pulvinaria sp.	Couch grass	Elgon
Aspidiotus hederae	Lemon	Naivasha
Coccus hesperidum	Citrus	Naivasha and Nairobi
Eriococcus auraucariae	Auraucaria	Nairobi
Gonipterus scutellatus	Gums	South Kinangop
Lepidosaphes beckii	Grapefruit	Ruiru
Chrysomphalus dictyospermi	Grapefruit	Ruiru
Mylabris bipartita	Dolichos	Nakuru
Nezara sp.	Castor	Kitui
Oxycarenus sp.	Cotton	Matuga
Aulacaspis cinnamomi	Mango	Nairobi
Hemiberlesia lataniae	Mango	Nairobi
Ptyelus sp.	Jacaranda	Nairobi
Agromyza obtusa	Eriosoma	Hoey's Bridge
Lonchaea mochii	Cynodon dactylon	Hoey's Bridge
Lagria villosa	General garden pest	Nairobi
Lagria viridipennis	General garden pest	Nairobi
Ptinus testaceus	Stored Wheat	Mombasa
Tribolium castaneum	Stored Rice	Mombasa
Calandra oryzae	Stored Rice	Mombasa
Ahasverus advena	Stored Rice	Mombasa
Oryzaephilus surinamensis	Stored Rice	Mombasa
Carpophilus sp.	Stored Rice	Mombasa
Tetranychus sp.	Cucumber	Nairobi
Haltica sp.	Rhubarb	Nakuru
Taeniothrips gladioli	Gladiolus	Nairobi
Rhinostomus afzeli	Coco-nut	Msambweni
Carpophilus dimidiatus	Stored Beans	Mombasa
Planococcus citri	Spartium junceum	Nairobi
Coccus africanus	Tea	Kericho
Chilo suppressalis	Maize	Msambweni
Cerataphis sp.	Roses	Mombasa

LIST OF INSECTS IDENTIFIED IN 1951 BEING NEW RECORDS FOR KENYA

TRYPETIDAE—		
Dacus pectoralis cucumaris	from Cucurbits	Dandora
Carpophthoromyia dimidiata	from *Drypetis* sp.	Nairobi
Dacus siliqualactis ..	from *Asclepias physocarpa*	Ruiru
Isoconia axilatra		Kiambu
Chelyophora magniceps ..		
Isocondia frondifer		Kiambu
AGROMYZIDAE—		
Agromyza obtusa	Pigeon Pea	Kiambu
EPHYDRIDAE—		
Ephydra riparia	Soda Lake	Magadi
SCOLIIDAE—		
Scolia ebenina disparatis ..		Diani Beach
Campsomeris thoracica coelebs		Gazi
Scolia perpolita perpolita ..		Nairobi
PTEROMALIDAE—		
Aplastomorpha calandrae ..	On *Calandra oryzae* ..	Nairobi
ACRIDIDAE—		
Acrida stali		Kericho, Kibwezi
CURCULIONIDAE—		
Rhinostomus afzeli	Coco-nut	Msambweni
ALEYRODIDAE—		
Siphoninus finitimus ..	*Olea europea*	Nairobi
BLASTOBASIDAE—		
Auximobasis ? glandulella ..	Tea seed	Tanganyika
PYRALIDAE—		
Mussidia nigrinivella ..	Wild Fig	Nairobi
Ancylolomia croesus ..		Nairobi
Ancylolomia chrysographella		Nairobi
NOCTUIDAE—		
Metapioplasta olivescens ..		Nairobi
HYPONOMEUTIDAE—		
Hyponomeuta morbillosa ..	*Elaeodendron*	Kabete

Biological Control

The amount of work on biological control is growing yearly and includes both import and export of beneficial insects, and the rearing of large numbers of certain species. This work will be summarized under the following heads: –

IMPORT

(*a*) *Hyperaspis jocosa* predacious on *Orthezia insignis*.—This Coccinellid was made available to us during the year by Mr. Gardner, Entomologist of the Forest Department who gave us an initial rearing stock numbering 26 adult beetles. It was considered that the liberations made up to that time had been too small to give full opportunity to the beetle and it was decided to put it into large-scale production. A satisfactory technique of rearing in glass preserving jars was worked out and during some periods the production averaged approximately 1,000 beetles a day. This work was carried out under the supervision of Mrs. S. Lowe, Laboratory Assistant. The liberations were made in Nairobi and area, and by post in Kisumu, Embu, Fort Hall, and other places in Kenya. Beetles were also provided to Uganda and Tanganyika. Up to the end of the year some 70,000 beetles had been liberated. It is considered that this gives a satisfactory trial and the effect of the beetle should be known in the near future. Already a considerable number of field-bred larvæ and adults are present.

(*b*) Other insects to control *Orthezia*.—A study of the natural enemies of two species of Orthezia in Trinidad has been begun at our request by the Trinidad Station of the Commonwealth Institute of Biological Control. They have already discovered three natural enemies which may be of value; a Drosophilid fly the larvæ of which live in the ovisac of the scale, another species of the Coccinellid genus Hyperaspis, and a Syrphid fly. Shipments of the first of these have already been received but the flies did not survive, having probably been chilled in the aircraft. Measures to overcome this will be taken. Shipments of the other beneficial insects found will also be made.

(*c*) Scoliid parasites for chafer grub.—This work is described above by Mr. Graham.

(*d*) Biological control of *Lantana camara*.—Plans to introduce from Hawaii the Tingid bug *Teleonemia scrupulosa* to prey on this weed have been made. This will be done on an exchange basis for parasites mentioned under Export (*a*).

EXPORT

(*a*) It is planned to send parasites of the Diamond Back Cabbage Moth *Plutella maculipennis* to Hawaii. Previous work of the section has turned up a large number of natural enemies of this important pest.

(*b*) The shipment of *Apanteles sesamiae* parasite of the maize stalk borer to Mauritius has begun. It is to be tried there against related lepidopterous borers of sugar-cane.

(*c*) Mr. N. L. H. Krauss of Hawaii was in Kenya during the year to collect natural enemies of the Giant African Snail and *Oryctes* sp. for Hawaii and Pacific islands. Assistance was given him in the search for *Scolia ruficornis* in our coastal area and fair numbers were found at Msambweni, but he later found Zanzibar a more profitable source of these insects. He also successfully shipped natural enemies of the Giant African Snail.

(*d*) On behalf of California we made some shipments of natural enemies of *Saissetia oleæ* but have failed as yet to obtain the species of *Encyrtus* especially desired. These shipments will be continued as opportunity permits.

Publications

Use of Benzene Hexachloride for Disinfestation of Stored Products, K.I.O. No. 197 (2660).

Termite Control with Toxic Smoke, Le Pelley, K.I.O. 200 (2711).

Maize Stalk Borer, K.I.O. 206 (2769).

Control of Some Wheat Pests, K.I.O. 209 (2800).

Importation of Fresh Fruit from India and Pakistan, K.I.O. 210 (2819).

Plant Protection Ordinance—Restriction on the Importation of Coniferous Trees, K.I.O. 212 (2839).

Importation of Fresh Fruit into Kenya from India, Pakistan, and all parts of Asia, K.I.O. 214 (2867).

Control of *Heteronychus* Black Wheat Beetle of Ol Kalou and Ol Joro Orok Areas, K.I.O. 220 (2942).

Use of Benzene Hexachloride for Disinfestation of Stored Products, K.I.O. 220 (2940).

Introduction of Wasps to Destroy Chafer Grubs, *East African Standard*, October.

The Reporting of Locust Swarms, K.I.O. 202 (2736).

Locust Control—Its Aims and Limitations, K.I.O. 203 (2746).

Observations on the Chafer Grub, R. H. Le Pelley, *East African Agricultural Journal*, Vol. XVII, No. 2, October, 1951.

Acknowledgments

I should like to acknowledge the good work of all the European and African members of the section.

We are most grateful for the help of many members of the field staff of this department, particularly during visits to their districts.

Once again it is a pleasure to acknowledge the advice and help of the Commonwealth Institute of Entomology. This is invaluable and essential to the department's work.

J. F. GRAHAM,
for Senior Entomologist.

ANNUAL REPORT OF THE SENIOR PLANT PATHOLOGIST, 1951

Investigational and Advisory

Coffee, cotton, and forestry and timber diseases are dealt with by their respective specialist teams and are not, therefore, included in this report.

The unusually heavy and prolonged rains throughout most of Kenya resulted in certain diseases reaching epidemic proportions.

Potato and tomato blight, *Phytophthora infestans,* was exceptionally severe throughout the Highlands. Many crops of susceptible varieties of potatoes at the higher altitudes were a total loss and few crops of tomatoes grown during the rainy period produced any return.

The widespread attack by *P. infestans* on perennial wild *Solanums,* referred to in the previous report, has apparently, as was anticipated, resulted in the appearance of yet further biotypes of the fungus. Two new biotypes, G. and H., have been recognized on material sent from Kenya to Dr. W. Black at the Plant Breeding Station, Corstorphine.

With the appearance of these new biotypes the hitherto immune hybrids from Dr. Black were all attacked to a greater or lesser extent. Nevertheless, all these proved to be greatly superior in performance to the non-resistant varieties still in cultivation. Some, although attacked, showed a decidedly resistant type of reaction. A number of these varieties are in commercial production by farmers.

Dr. Black's hybrids immune from biotypes A. and C. only have been largely discarded. A later introduction, 1512d4 immune from biotypes A., B., C., E., F., shows much promise. In Kenya it has a longer dormant period and may prove of value to areas with only one planting season. Dutch Robyjin is now widely grown and shows some resistance to blight. The present stocks originated from 14 lb. obtained from John Clarke of Ballycastle in 1946, following a trial of a few tubers kindly supplied by Dr. Salaman the previous year. Dutch Robyjin is said to have a higher protein content than other domestic varieties. It is much sought after by Africans who claim that their children can withstand longer intervals between meals when fed on Dutch Robyjin than they can on other varieties.

Alternaria solani, frequently severe on potatoes and tomatoes in normal years, appeared to be suppressed by the prevailing wet weather.

Other diseases of these hosts reaching the laboratory included: *Cercospora concors, Spongospora subterranea,* an unidentified species of *Fusarium* not *F. caeruleum* on potatoes; *Phoma destructiva* and severe attacks of *Cladosporium fulvum* on tomatoes.

The root knot eelworm was severe on tomato roots and occasionally on potato tubers.

The most important disease of wheat was "Take-All", *Ophiobolus graminis*, recorded during the year only on that host. The increased number of reports is considered to be due to a flare up of existing foci during the wet growing period rather than any general extension of the disease. Continuous cropping of wheat is still a main factor in survival, aggravated by the ploughing in of stubble. Monoculture and ploughing in of stubble instead of burning are incompatibles.

Following suggestions that there are varietal differences in susceptibility to the disease, an experiment is in progress.

No serious instance of stem rust was received, this disease being adequately controlled by the resistant varieties available. Yellow rust occurred only incidentally with other diseases.

The exceptionally long wet period during ripening and harvesting of wheat resulted in a number of specimens being received with blackening of the ears and light grain. Of the fungi isolated, *Septoria nodorum* was the most serious. Superficial fungi included *Alternaria tenuis, Epicoccum* sp., *Cladosporium herbarum* and *Aspergillus flavus*.

A severe outbreak of Spot Blotch (*Helminthosporium sativum*) of barley occurred in various districts.

On maize, severe attacks of *Helminthosporium turcicum* were received from Nairobi, Kitale and Kericho. *Fusarium graminearum* and *F. moniliforme* occurred as cob rots, and the latter as a seedling and pregermination disease. Only one instance of *Puccinia sorghi* was reported, which disease is at times severe during seasons of normal or low rainfall.

The unidentified disease, which is presumed bacterial and known locally as Trans Nzoia disease, appeared east of the Rift Valley.

Grasses and fodder crops were also affected by the wet conditions. Rhodes Grass, Molasses Grass, *Cynodon* spp., *Brachiaria brizantha* and spp. were attacked in the ear by the Sphacelia stage of Ergot and by *Cerebella*, as were many wild grasses. Sclerotia of Ergot were found on *Brachiaria brizantha* and other *Brachiaria* species, *Panicum maximum* and *Andropogon schinzii*. *Fusarium* and *Cerebella* combined were of frequent occurrence. A white leaf-spot of Molasses Grass was caused by a species of *Cercospora*. A species of *Tilletia* (?) was received on *Setaria aurea*.

Diseases received on lucerne were *Pseudopeziza medicaginis, Sphaerulina trifolii, Uromyces striatus* and *Peronospora trifoliorum*.

Diseases on other miscellaneous fodder crops were *Penicillium* spp. and *Trichurus gorgonifer* on Astragalus; *Botrytis cinerea, Epicoccum purpurascens* and *Alternaria tenuis* on *Stylosanthes gracilis* (Brazilian lucerne); and a severe bacterial soft rot of Japanese radish.

In addition to Mosaic and Brown Streak, Cassava was attacked by *Cercospora henningsii* and tuber rot caused by *Rhizopus nigricans*. Castor oil at the coast suffered from attacks of the inflorescence by *Aspergillus* spp. and *Macrophoma* sp. From the same district premature fruit rot of coco-nuts was associated with *Diplodia natalensis*. Flax was attacked by *Sphaerella linorum, Phoma* sp. and *Fusarium scirpi*. Lupin seedlings were attacked by damping-off caused by *Rhizoctonia solani* and mature plants by a *Fusarium* wilt. *Glœosporium* canker again occurred on the stems of Safflower. Sunflower was again attacked by Rust (*Puccinia helianthi*) and *Cystopus tragopogonis* and severely by *Sclerotinia sclerotiorum*. A species of *Hypoxylon ?michelianum* occurred on a stump rot of tea and *Colletotrichum camelliæ* on leaves of the same host.

Diseases of apples included *Rosellinia necatrix*, Crown Gall and Apple Mosaic. *Cephaleuros* sp. occurred on avocado pear, and an undescribed species of *Ascochyta* on *Anona*, previously recorded only from Limuru, was sent in from Nanyuki. Severe defoliation of Rough Lemon was caused by *Alternaria citri*; a branch canker of citrus was caused by *Fusarium* sp. *Corticium salmonicola* and *Penicillium glaucum* occurred on branch and fruit respectively of orange. *Cerotelium fici* caused severe leaf fall of fig. Grape vines were attacked by *Elsinoe ampelina, Septoria* sp. on leaf petioles, *Uncinula necator* and *Plasmopara viticola*. Peach was attacked more severely than usual by *Taphrina deformans*. Instances of "Stony Pit" of pears were received. *Armillaria mellea* collar rot and aerial galls of Crown Gall occurred on plum.

Diseases of vegetables included *Botrytis cinerea* shoot canker of artichoke, *Puccinia asparagi* and *Ascochyta* sp. on asparagus; *Sclerotinia sclerotiorum, Ascochyta* sp. and *Colletotrichum lindemuthianum* on French beans; *Botrytis fabæ* and *Uromyces fabæ* on Vicia; *Septoria apii-graveolentis* on celery; *Pseudoperonospora cubensis* on cucumber; *Septoria vignæ* and *Erysiphe polygoni* on cowpea; *Botrytis cinerea* stem canker and leaf spotting on groundnuts; *Septoria lactucæ* on lettuce; *Aspergillus niger, Alternaria porri, Peronospora destructor* and *Stemphylium botryosum* on onion; *Ascochyta pisi* and *Erysiphe polygoni* on pea; *Fusarium* wilt of pigeon pea, and *Cercospora beticola* on spinach beet.

Ornamentals accounted for a number of inquiries and visits. The following diseases or pathogens were identified: *Fusarium* wilt and an unidentified severe leaf spotting and stem canker of *Antirrhinum*; *Septoria gerberæ* on *Gerbera*; *Cercospora calotropidis* on *Calotropis procera*; *Septoria dianthi, Heterosporium echinulatum, Fusarium* wilt and a possible virus disease on carnations; *Puccinia chrysanthemi* on chrysanthemum; bacterial corm rot of cyclamen; *Uredo cryptostegiæ* on *Cryptostegia grandiflora*; *Botrytis cinerea* bud rot and *Entyloma dahliæ* on dahlias; *Sclerotinia sclerotiorum* on gazania; *Botrytis* sp., *Uromyces gladioli* and a *Penicillium* transit rot of gladiolus; *Didymellina macrospora* on iris; *Septoria* sp. leaf blotch of *Knipholfia*; *Diplocarpon rosæ, Sphaceloma rosarum, Cercospora rosicola, Phragmidium tuberculatum* and a bud blight caused by *Botrytis cinerea* on rose; one instance of extreme fasciation of rose was also received. Violets were attacked by a supposed virus disease, causing distortion of the leaves and necrotic patches.

Miscellaneous fungi received were: *Puccinia abutili* on *Abutilon zanzibaricum, Aecidium* sp. on *Coccinea grandis, Puccinia leonotidicola* on *Leonotus nepetæfolia, Puccinia pentanisiæ* on *Pentanisia ouranogyne*.

Pyrethrum bud disease.—Intermittent studies, as opportunity has permitted, have been made on the fungus *Ramularia bellunensis* (determination on Kenya material by Commonwealth Mycological Institute).

A feature of the disease is the variability of its incidence in different localities and in different seasons. No outbreak has been so severe as the first recorded one in 1946. It seems that the incidence of the disease is correlated with conditions of alternating high and comparatively low humidity. Observations indicate that outbreaks are likely at high altitudes where mists persist for some hours in the mornings and where there are heavy dews. During periods of high humidity sporodochia become active and produce spores from the conidiophores in acropetal succession. It is suggested that subsequent dispersal of these takes place during the intervening drier periods rather than by rain splash. In a comparatively dry atmosphere the conidia are readily detached by air currents. This is made use of in obtaining cultures in the laboratory. Owing to the slow and very restricted mycelial development, the conventional method of using a spore suspension on agar plates was rarely successful. It is found a more satisfactory method to blow

the conidia lightly on to the surface of the agar with no film of moisture present. The conidia themselves being dry grow without any adherent film of moisture. A high proportion remains free from bacterial contamination. The degree of dispersal can be roughly regulated by distance and the source and strength of the air current.

The conidia germinate in three to four hours at laboratory temperature but subsequent development on agar is slow, a ten-day culture on malt agar from a single spore being about 1 mm. in diameter and height.

Infection of the inflorescence can apparently take place from the earliest stage of development of the bud to the mature flower. Most infections occur at an early stage, preventing further development of the bud, which accounts for the disease being known as "Bud Disease". Infection appears usually to start on the involucral bracts. Flowers with only one bract infected and showing sporodochia are seen. The involucre of a half-developed flower with only one bract infected became fully discoloured in five days. Mature flowers are occasionally seen with one sector only infected, but causing little or no distortion suggesting a rapid penetration of the fungus. That the majority of fully infected buds are equally without distortion points similarly, unless it can be shown that the base of the involucre or top of stem is first cut off by invasion of the fungus. The sequence of penetration and invasion is a subject for study.

Normally, only the distal inch or two of the flower stalk below a diseased bud or flower is infected and bears in the longitudinal furrows a close growth of sporulating sporodochia. The fungus permeates the tissue of the involucre and fills the hollow space immediately below the flower with mycelium. On buds and flowers profuse production of sporodochia occurs on the inner surface of the involucral bracts. Their presence here provides a certain diagnosis of the disease when they cannot readily be detected on the outside. Here the sporodochia occur on the ridge of the outer bracts. Inside the bracts sporodochia occur on the achenes and on the corolla tubes of disc and ray florets and at the base of the ray petals.

Rarely plants are found with withered and twisted leaves bearing profuse sporodochia. These are deep seated in the leaf tissue with conidiophores protruding on both leaf surfaces through the stomatal opening. Why this form of infection should occur so infrequently or whether it is the same strain of the fungus, is not known. It is clear that the foliage of all plants bearing diseased buds and flowers must be subjected to the chance of infection.

Sclerotia are formed on the inner surface of the involucral bracts. They possibly develop from the sporodochia and occur in greater profusion at the base. It would seem that neither these sporodochia nor sclerotia can play any part in the dissemination of the fungus until the achenes are shed. Sclerotia also occur more rarely on old stems. Under what conditions they form is not yet known. It is unusual to find the sporodochia on the stems except immediately below the buds. Their appearance may possibly be a saprophytic invasion of dead tissue before it is fully colonized by other fungi. The sclerotia on the bracts are of a softer consistency than those on the stems and may more nearly approach a true fructification. Those on the stem are carbonaceous with no clearly differentiated outer layer. It is probable that the structure and development of the sclerotia follow that of *R. vallisumbrosæ* as described by Gregory.

The sclerotia, in a saturated atmosphere, produce a tuft of conidiophores or the rudiments of a sporodochium on the exposed surface. The conidia resemble those borne by the primary sporodochia. No scolecospores as described by Gregory for *R. vallisumbrosæ* have been seen.

In East Africa, the pyrethrum plant is an exotic. The sclerotia here are true organs of æstivation in that they produce a conidial stage after dry, hot "summer" periods. It is, however, to be demonstrated whether they play any essential part in the initiation of fresh outbreaks. There being no "winter", buds and flowers in varying stages of development are usually present in the crop. The sporodochia can withstand desiccation for some months so that the presence of the sclerotia need not necessarily be postulated for the carry over of the fungus during dry intervals.

Other fungi commonly associated with diseased buds and intermingled with sclerotia on dead stalks are: *Fusarium, Pleospora* sp., *Microdiplodia, Coniothryium, Botrytis cinerea, Alternaria* and *Cladosporium.*

Preliminary attempts at inoculation of the buds and flowers have failed. The methods so far tried consisted of using as inoculum pieces of sporulating agar culture, blown dry conidia, water suspensions of conidia, and pieces of bracts and stem bearing actively sporulating sporodochia. These have been placed, without wounding, on buds, flowers, and stem immediately below buds. Similar inocula have been used on wounded buds, inserted beneath the bracts and conidial suspensions injected into the hollow space below the bud. Inoculated plants and detached buds and flowers were kept in a saturated atmosphere at room temperature. Opportunity has not permitted the repetition or variation of these attempts or the trials of other techniques during the period under review.

Successful inoculations have, however, been made on the leaves of seven-week-old seedlings. Conidia were blown on to atomized leaves. Lactic phenol preparations showed the conidia to have germinated with mycelial growth but with no apparent preference for the stomata. No penetration may occur when the conidium actually alights on the stomatal opening. Eleven days after inoculation, sporodochia developed in the sub-stomatal cavities with the protrusion of conidiophores bearing typical *Ramularia* conidia through the opening. A development of this technique might be used for the determination of inherent susceptibility or resistance to the disease. The possibility of a practical control of the disease by spraying with fungicides has long been considered. Copper sprays were not at first used as the view was held that copper was inimical to the development and assay of pyrethrins. A trial with Perenox done for the scientific adviser to the Pyrethrum Board proved this view to be a mistaken one.

The effect on the germination of conidia of some fungicides has been observed. In addition to the previously reported tests with Malachite Green 1:10,000 and Tulisan, both of which were found to stop germination, further trials have been done with Perenox and organic fungicides from the United States. 0.5 per cent Perenox stopped germination but did not prevent sporodochia from producing viable conidia 48 hours after being dipped in the fungicide. Of the American fungicides only Zerlate and Phygon were as fungicidal as Tulisan and Perenox. Fermate, Dithane and Parzate did not stop germination at the recommended strength for spraying. Fermate had a greater inhibiting effect than Parzate, with Dithane midway between the two. The last three are considered unlikely to be of much practical value unless the systemic fungicidal action of Dithane can be turned to account.

Spraying trials were done with Perenox at monthly intervals over several months at the Scott Laboratory. As no bud disease appeared it was not possible to assess the value of the treatment. The addition of a white oil emulsion greatly improved the spreading and persistence of the fungicide. It was thought that the oil might have some effect in sealing the sporodochia. Bordeaux mixture was not included in any later trials as it was considered that the practical difficulties in its preparation in Kenya would not appeal to the growers.

More extensive trials of these fungicides were done in the Molo district. The account of these will be found in the report of the Assistant Agricultural Officer (Pyrethrum), Molo.

At the end of the year the Pyrethrum Board was fortunate enough to obtain the advice on the investigation and control of the disease of Dr. P. H. Gregory of Rothamsted, who visited the Colony in December. Dr. Gregory's views and advice on future work are much appreciated. It is understood that Dr. Gregory is now with the co-operation of the East African Agriculture and Forestry Research Organization studying the disease at Rothamsted.

Stem Rust of Wheat.—Of the 39 tests for identification done on the previous year's (1950) collections, K9 and K1 were of the most frequent occurrence. K7 was identified once. During the testing of this material two apparent forms appeared, K10 and K11.

K10 follows the same reactions as K5, except that those on Kenya Governor and Einkorn are reversed. It was originally isolated from Kenya Settler which had been shown resistant to forms 1–8. K11 is susceptible on 112 and 58 only. The original isolation from 294M has been lost.

Of the material collected during the present year, part of which will be tested in 1952, the predominant form was again K9, to which a number of the wheats in cultivation are susceptible. K10, K6 and K11 also appeared; new stock cultures were obtained of the latter. There are already indications of yet another form having appeared.

Of the 42 tests of seedling hybrids to K9, 18 showed resistance, three gave R-S reactions and the remainder were susceptible.

Inoculations on the American differentials of Stakeman and Levine indicated that K9 was close to race 34 or race 107, the result on Kota being inconclusive. Exact agreement with the American reactions had not been found to occur with the Kenya rusts under the conditions of the tests.

Similar work started with K11 had to be abandoned on account of contamination of the culture and subsequent loss of the form.

Owing to occasional conflicting results between seeding tests and behaviour in the field, mature plant inoculations in addition to seedling tests were started. These have had to be discontinued on account of staff changes and shortages.

Legume Inoculants.—By the end of the year the number of strains in culture was 19. Imported strains were from Dr. Thornton (Rothamsted), Dr. Allen (U.S.A.), Messrs. Dalgety's (*ex* Australia), and Dr. Wallace (*ex* Rothamsted).

Several isolations were made locally, that for Serradella (No. 19) appeared superior to any of the imported strains when tested on a non-nitrogenous agar medium. The method has been used for the elimination of inefficient strains of lucerne and lupin bacteria.

Mycological Herbarium.—The following identifications were received from the Commonwealth Mycological Institute of fungi sent during 1951:—

Aecidium ?habunguense on *Solanum indicum, A. vitis* on *Cissus erythrochlora, Aspergillus itaconicus* on *Mangifera indica* and *Ricinus communis, A. luchuensis* on *Mangifera indica, A. niger* on *Agave sisalana* and *Mangifera indica, A. quercinus* on *Ricinus communis, A. repens* (laboratory contaminent), *Botryodiplodia theobromæ* on *Ipomea batatas, Ceratostomella paradoxa* on *Cupressus macrocarpa, Cerotelium fici* on *Ficus carica, Chætomium cochlioides* on *Acacia molissima, Cunninghamella echinulata* from greenhouse soil, *Hamaspora longissima* on *Rubus* sp., *Helminthosporium gramineum* on *Hordeum vulgare, H. turcicum* on *Sorghum vulgare, Hypoxylon michelianum* on *Thea sinensis*; *Melampsora lini* on *Linum usitatissimum, Myrothecium roridum* on *Triticum vulgare, Phragmidium tuberculatum* on *Rosa* sp., *Puccinia africana* on *Spilanthes*

acmella, *P. aurata* on *microglossa volubilis*, *P. alii* on *Allium cepa*, *P. glumarum* on *Hordeum vulgare*, *P. graminis* on *Secale cereale*, *P. helianthi* on *Helianthus annus*, *P. leonotidicola* on *Leonotis nepetæfolia*, *P. leveillei* on *Geraneum aculeolatum*, *P. lippicola* on *Lippia asperifolia*, *P. pegleriana* on *Cyperus blysmoides*, *P. pentanisiæ* on *Pentanisia ouranogyne*, *P. sorghi* on *Zea mays*, *P. versicolor* on *Ischæmum brachyantherum*, *Ravenelia minima* on *Albizzia* sp., *Rhizoctonia lamellifera* on *Jacaranda mimosæfolia*, *Sclerotinia minor* on *Chrysanthemum cinerarifolium*, *Trichothecium roseum* (laboratory contaminent), *Uromyces alchemillæ* on *Alchemilla* sp., *U. ecklonii* on *Freesia* sp., *U. harmsianus* on *Crotolaria* sp., *U. hobsoni* on *Jasminum* sp., and *U. renovatus* on *Lupinus alba*.

The following were not fully identified:—

Helminthosporium sp. (possibly *cynodontis*) on *Cynodon transvaalensis*, *Pestalotiopsis* sp. on *Cesalpinia sepiaria* and *Uredo* spp. on *Kyllinga* sp., *Cypholepis jemenica*, *Arctotis grandis* and *Landtia schimperi*. (The fungus on the two latter was suggested to be the same and one not previously described.)

A species of *Hymenomycete* from a termitarium was also thought to be new.

Publications

"'Canker' or 'Blackleg' Disease of Cabbages and Cauliflower." *East African Agricultural Journal*, XVI, 4, 178.

"A Botrytis Disease of *Urena Lobata* in Kenya." *Idem* XVI, 4, 181.

With Moira Ryan:—

"New Hosts of *Phytophthora infestans* in Kenya." Nature, 168, 85.

Seed-testing

A series of tests were done on the treatment of *Hibiscus* seed to hasten germination. It was found that, in some instances, plunging the seed in boiling water and leaving for 48 hours, followed by drying at 40° C. for seven days, had the desired effect. In other instances it was necessary to place the seed in concentrated sulphuric acid for two hours to produce a similar result.

Seedlings from various fibre crops, germinated in the Seed Laboratory, have been grown on to maturity for botanical record and subsequent planting out in the field.

Heliopsis spp. seed, imported by the Pyrethrum Board from the U.S.A., was germinated in the laboratory and grown on in the nursery for tests for toxicity of the powdered roots by the Senior Chemist (Pyr.). It is reported as being less quick-acting than pyrethrum powder. Treatment with sulphuric acid hastened germination.

Germination tests were done on lots of tea seed experimentally fumigated by the Senior Entomologist. Chemical and hot water treatments were used. Hot water treatment apparently stimulates germination and further tests are being done. The most efficient treatment was water between 52° C. and 54° C. for 30 minutes. A temperature of 60° C. proved lethal. The tetrazolium test gave comparable results in indicating viability.

A number of species of plants from weed seeds found in seed samples was raised and grown to maturity for identification. Seventy-two pressed specimens of plants, mostly weeds of agricultural land, were added to the economic herbarium. Of these, ten remained unidentified.

Thirty-nine specimens were identified for members of the public.

Seed-borne fungi, visibly contaminating seed samples, or developing during the germination test, were passed to the pathological laboratory for identification.

R. M. NATTRASS,
Senor Plant Pathologist.

ANNUAL REPORT OF THE SOIL CHEMIST, 1951

Meteorological

The following summarizes meteorological data obtained at Scott Agricultural Laboratories during 1951:—

Month	Absolute		Mean		Rainfall	Sunshine
	Max.	Min.	Max.	Min.		
					inches	*hours*
January ..	85·0	50·2	80·9	54·2	0·24	313·8
February ..	84·9	52·2	81·4	56·6	0·18	261·4
March ..	84·5	55·0	79·0	57·5	4·37	233·0
April ..	76·9	55·1	73·8	57·8	13·25	113·6
May ..	76·0	54·0	71·6	57·3	8·33	161·5
June ..	75·5	53·5	70·8	54·9	7·85	139·0
July ..	78·4	48·5	70·9	53·4	1·64	164·5
August ..	75·8	48·9	68·3	52·9	0·96	66·4
September..	84·1	46·3	77·2	53·7	0·07	222·6
October ..	85·5	56·0	76·0	57·2	3·87	166·8
November..	80·0	54·4	74·4	57·6	5·68	206·5
December..	80·0	55·0	73·0	57·3	8·61	211·7
Year ..	85·5	46·3	74·8	55·9	55·05	2,280·8

The year opened dry and the 1950 short rains plantings generally were droughted and failed. The long rains, on the other hand, were heavy and exceptionally protracted. The short rains also were prolonged and heavy and persisted well into 1952.

In consequence, while vegetative, particularly weed, growth was great in the 1952 plantings, crop yields generally were disappointing and great difficulty was experienced in keeping the station farm clean. Long rains planted sorghum was particularly affected.

Experimental Work

Phosphate Trials

The biological assays carried out during 1950 on the availability of different phosphatic fertilizers were continued.

Field Studies of Phosphate Fertilizers

Trials reported in the 1950 annual report had confirmed observations made in previous years that the availability to the plant of the phosphate in soda-phosphate was at least as great as that of the phosphate in concentrated forms of superphosphate. At the same time, they showed that phosphate uptake may be smaller and less useful to the plant when the concentration of sodaphosphate in the placement zone is high than when it is low.

Trial 9/1 *of* 1951 had as its object the comparison of the effect of different concentrations of sodaphosphate and superphosphate in fertilizer placement zones on the phosphate uptake of wheat seedlings when grown under conditions of unrestricted rooting in a soil of recognized high phosphate-fixing power.

Treatments and Design

Two forms of phosphate: Sodaphosphate *vs.* Double supers combined factorially with two levels of application of phosphate: .00625 grm. *vs.* .0125 grm. available P_2O_5 applied per plant and eight concentrations of added phosphate in the fertilized zone: 10.24 per cent *vs.* 5.12 per cent *vs.* 2.56 per cent *vs.* 1.28 per cent *vs.* 0.64 per cent *vs.* 0.32 per cent *vs.* 0.16 per cent *vs.* 0.08 per cent w/v available P_2O_5 in the fertilized zone. The trial was laid out in eight blocks each of eight randomized plots on a part of Scott Agricultural Laboratories grounds which had been under prolonged cultivation. The fertilizer was placed in the same manner as was adopted in the 1950 studies of the effect of varying concentrations of sodaphosphate on plant growth and phosphate uptake from soil in boxes.

Plot Size.—Seven rows at 7-in. spacings each of 80 seeds at ½-in. spacing in the row.

The aereal parts of approximately alternate seedlings in the second, fourth, and sixth rows of each plot was harvested on the 21st day after planting, leaving 40 plants in each row, the plants harvested from the last eight hills at each end of each row being discarded as guard plants. Similar harvestings of alternate plants from the remaining plants in the second, fourth and sixth row of each plot were carried out on the 35th and 49th day after planting and a final harvest of all the plants left in these rows was carried out on the 63rd day after planting. The mean dry weight and the mean phosphate uptake per seedling were among the determinations made on each harvest of each plot.

Results.—The following tables give the essential data obtained:—

(1) Dry Weights of Seedlings: mgm. per Plant

	Concentration of Available P_2O_5 in Fertilized Zone: Per cent w/v.								
	10·24	5·12	2·56	1·28	0·64	0·32	0·16	0·08	Mean
First Sampling:									
Sodaphosphate—									
Low Level ..	28·8	30·7	31·2	30·4	29·5	29·1	31·9	32·1	30·4
High Level ..	28·8	31·5	31·6	35·8	32·6	34·5	35·2	34·7	33·1
Mean	28·8	31·1	31·4	33·1	31·1	31·8	33·5	33·4	31·8
Superphosphate—									
Low Level ..	31·3	31·1	31·8	31·1	30·8	30·8	51·3	36·1	34·7
High Level ..	28·8	36·5	33·6	33·8	34·1	33·0	36·0	39·6	34·4
Mean	30·0	33·8	32·7	33·5	32·5	31·9	43·7	37·9	34·5
Mean—									
Low Level ..	30·0	30·9	31·5	31·7	30·2	30·0	41·6	34·1	32·
High Level ..	28·8	34·0	32·6	34·8	33·3	33·8	35·6	37·1	33 8

Differences were not significant.

	Concentration of Available P_2O_5 in Fertilized Zone: Per cent w/v.								
	10·24	5·12	2·56	1·28	0·64	0·32	0·16	0·08	Mean
Second Sampling:									
Sodaphosphate—									
Low Level ..	92·5	80·5	115·0	91·0	81·5	89·5	102·5	109·5	95·2
High Level ..	80·0	110·0	86·0	110·0	134·5	115·5	112·5	131·0	109·9
Mean	86·2	95·2	100·5	100·5	108·0	102·5	107·5	120·2	102·6
Superphosphate—									
Low Level ..	87·5	100·0	86·5	92·0	89·0	82·0	109·0	127·0	97·9
High Level ..	104·0	114·5	117·5	116·0	110·0	116·5	141·5	155·5	121·9
Mean	95·7	107·2	102·0	104·0	99·5	104·2	125·2	141·2	109·9
Mean—									
Low Level ..	90·0	90·2	100·7	91·5	85·2	90·7	105·7	118·2	96·6
High Level ..	92·0	112·2	101·7	113·0	122·2	116·0	127·0	143·2	115·9
Mean	91·0	101·2	101·2	102·2	103·7	103·3	116·3	130·7	106·2

Differences were significant (P=5 per cent): standard error of mean of single treatment combination=14·7.

	Concentration of Available P_2O_5 in Fertilized Zone: Per cent w/v.								
	10·24	5·12	2·56	1·28	0·64	0·32	0·16	0·08	Mean
Third Sampling:									
Sodaphosphate—									
Low Level ..	392	419	468	470	415	466	579	577	474
High Level ..	360	519	491	473	531	708	596	574	532
Mean	376	469	479	472	473	588	587	576	503
Superphosphate—									
Low Level ..	436	523	411	443	484	541	467	647	496
High Level ..	472	571	654	718	454	510	717	770	608
Mean	459	547	533	581	469	525	592	709	552
Mean—									
Low Level ..	419	471	440	457	450	504	523	612	485
High Level ..	416	545	573	596	493	609	656	672	570

Differences were not significant.

	Concentration of Available P_2O_5 in Fertilized Zone: Per cent w/v.								
	10·24	5·12	2·56	1·28	0·64	0·32	0·16	0·08	Mean
Fourth Sampling:									
Sodaphosphate—									
Low Level ..	574	552	690	636	477	506	724	650	601
High Level ..	553	683	573	582	692	790	683	684	655
Mean	564	618	632	609	586	648	703	667	628
Superphosphate—									
Low Level ..	609	596	546	649	656	686	733	891	671
High Level ..	592	728	777	787	691	680	892	931	760
Mean	601	662	662	718	674	683	813	911	716
Mean—									
Low Level ..	592	574	618	643	567	596	729	771	636
High Level ..	573	706	675	685	693	735	788	808	708

Differences were not significant

P_2O_5 Uptake by Seedlings: mgm. Per Plant

	Concentration of Available P_2O_5 in Fertilized Zone: Per cent w/v.								
	10·24	5·12	2·56	1·28	0·64	0·32	0·16	0·08	Mean
First Sampling:									
Sodaphosphate—									
Low Level ..	·240	·298	·389	·346	·275	·567	·444	·362	·365
High Level ..	·279	·402	·425	·410	·488	·469	·361	·512	·419
Mean	·259	·350	·407	·378	·332	·518	·402	·437	·392
Superphosphate—									
Low Level ..	·235	·314	·317	·327	·393	·253	·420	·572	·354
High Level ..	·294	·442	·453	·388	·389	·417	·565	·417	·421
Mean	·265	·378	·385	·358	·391	·335	·493	·495	·388
Mean—									
Low Level ..	·238	·306	·353	·337	·334	·410	·432	·467	·360
High Level ..	·287	·422	·439	·399	·438	·443	·463	·465	·420

Differences were not significant.

	Concentration of Available P_2O_5 in Fertilized Zone: Per cent w/v.								
	10·24	5·12	2·56	1·28	0·64	0·32	0·16	0·08	Mean
Second Sampling:									
Sodaphosphate—									
Low Level ..	·561	·482	·748	·432	·499	·624	·597	·724	·584
High Level ..	·499	·677	·578	·769	·976	1·026	1·032	·999	·820
Mean	·530	·580	·663	·601	·738	·825	·815	·861	·702
Superphosphate—									
Low Level ..	·551	·555	·460	·474	·556	·613	·655	·995	·608
High Level ..	·600	·722	·836	·686	·560	·651	·907	1·102	·758
Mean	·576	·639	·648	·580	·558	·632	·781	1·048	·683
Mean—									
Low Level ..	·556	·519	·604	·453	·528	·619	·626	·859	·596
High Level ..	·550	·700	·707	·728	·768	·838	·969	1·050	·789

Differences were not significant.

	Concentration of Available P_2O_5 in Fertilized Zone: Per cent w/v.								
	10·24	5·12	2·56	1·28	0·64	0·32	0·16	0·08	Mean
Third Sampling:									
Sodaphosphate—									
Low Level ..	2·16	2·27	3·00	2·88	2·36	2·84	3·67	3·89	2·89
High Level ..	2·25	3·43	3·08	2·87	3·34	5·20	4·44	3·75	3·55
Mean	2·21	2·85	3·04	2·88	2·85	4·02	4·06	3·82	3·22
Superphosphate—									
Low Level ..	2·48	3·05	2·66	2·75	2·97	3·73	2·66	3·88	3·03
High Level ..	3·17	3·61	4·17	4·83	2·96	3·24	4·48	5·25	4·03
Mean	2·83	3·33	3·41	3·79	2·97	3·49	3·82	4·57	3·53
Mean—									
Low Level ..	2·32	2·66	2·83	2·82	2·67	3·29	3·17	3·89	2·96
High Level ..	2·71	3·52	3·62	3·85	3·15	4·22	4·71	4·50	3·79

Differences were not significant.

	Concentration of Available P_2O_5 in Fertilized Zone: Per cent w/v.								
	10·24	5·12	2·56	1·28	0·64	0·32	0·16	0·08	Mean
Fourth Sampling:									
Sodaphosphate—									
Low Level ..	2·27	2·44	3·20	2·81	2·23	1·96	3·28	2·63	2·60
High Level ..	2·35	3·22	2·44	2·53	3·31	3·89	2·95	3·34	3·00
Mean	2·31	2·83	2·82	2·67	2·77	2·92	3·12	2·99	2·80
Superphosphate—									
Low Level ..	2·56	2·64	2·54	2·72	2·82	3·04	3·27	4·68	3·03
High Level ..	2·49	3·53	3·30	3·64	2·80	3·05	4·50	4·37	3·46
Mean	2·53	3·08	2·92	3·18	2·81	3·04	3·89	4·53	3·25
Mean—									
Low Level ..	2·42	2·54	2·87	2·77	2·52	2·50	3·28	3·65	2·82
High Level ..	2·42	3·37	2·87	3·09	3·06	3·47	3·73	3·86	3·23

Differences were not significant.

Sufficient precision was lacking for differences normally to be significant. Yet at every cut, the mean dry weight of the seedlings harvested and the amount of phosphate which each had taken up proved greater at the higher level of application than at the lower, the only exception being in the case of the dry weights of the superphosphate-treated plots in the first cut. A marked tendency was also apparent for dry weights per seedling and phosphate uptake per seedling to increase with decreasing concentration of phosphate in the fertilizer zone. Reducing the dry weights per seedling and the phosphate uptake per seedling for each concentration level of each fertilizer at each harvest to a percentage of the figure for sodaphosphate at the 10.24 per cent level as 100, the means for all four harvests of the percentages so obtained were found to be closely correlated with the logarithm of the fertilizer concentration in the fertilized zone. The gradients of the regression lines showed the rate of increase of dry matter per seedling with decreasing concentration of fertilizer to be significantly greater for superphosphate than sodaphosphate: no other significant differences between the regression lines were apparent. Though the uptake by the plant from sodaphosphate was not markedly different from that from superphosphates, it appears that the plant is somewhat less able to benefit from phosphate originating from sodaphosphate than from superphosphate, the mean dry weight for plants from the sodaphosphate-treated plots being generally somewhat less (but not significantly less) than the mean dry weight for plants from the superphosphate-treated plots. This effectiveness of superphosphate relative to sodaphosphate, as measured by the mean dry weight per plant, apparently is greater at low levels of concentration of fertilizer within the fertilized zone than at high levels. This is contrary to what was anticipated in laying out the experiment.

The correlation between phosphate uptake at various stages of growth and grain yields which it was hoped also to establish were frustrated through bird damage to the ripening grain.

Consideration is being given to ways of increasing the precision of the experiment sufficient for more differences of significance to be obtained.

Field Studies in Phosphate Fixation

Results reported in 1950 showed that the residual effect of heavy applications of phosphatic fertilizer in October, 1948, had become virtually undetectable in mature grass.

Trial 9/3 *of* 1951 had as its object to confirm the 1950 results on mature grass and to determine whether, through the analysis of young grass shoots, it was possible to detect a continued availability of phosphates from the fertilized plots which analysis of more mature material had failed to detect. The following gives details of harvests for 1951:—

Date		Control (mean of 6)	Rock phosphate (mean of 3)	Soda phosphate (mean of 3)	Super phosphate (mean of 3)
Mid-May, 1951	MATURE GRASS AND STEMS: 5 WEEKS GROWTH				
	Yield of D.M.: grms./plot ..	2170	2815	2244	1975
	Plot uptake: gm./plot ..	14·5	19·5	18·8	15·3
	Per cent P_2O_5 in D.M. ..	·64	·70	·84	·78
Late May, 1951	SELECTED SUCCULENT SHOOTS FROM REGROWTH AFTER ABOVE CUT: 2 WEEKS GROWTH				
	Per cent P_2O_5 in D.M. ..	1·28	1·40	1·68	1·56

Residual fertilizer effects were much greater than in 1950. The phosphate percentages P_2O_5 in dry matter for each treatment approximated closely to those observed by Mr. Gethin Jones in 1949 and the differences between fertilized and control plots were greater than the majority of those recorded by Mr. Dougall on the Pasture Research Organization fertilizer trials for 1951. The trial area was dug up in 1951 and a range of crops will be sown on the plots in 1952 to ascertain whether these phosphate reserves are available to young growing seedlings and whether they again produce the marked initial growth responses observed in 1948 and 1949 by Mr. Gethin Jones.

POT CULTURE STUDIES OF PHOSPHATE FERTILIZERS

Comparative pot culture studies on the availability of phosphatic fertilizers have in past years in the main been confined to studies on Kikuyu red loam. As this soil type is not at all widespread in the major general farming areas where crop fertilizing is normal practice, the need exists for the scope of pot culture work to be extended to soils of common occurrence in these areas.

Accordingly, *Trial* 9/4 *of* 1951 was laid down having as its object the examination of the response of young cereal seedlings to applications of phosphates and lime on an acid vlei soil from Ol Joro Orok of a type which is being extensively developed for wheat production under a system of surface drainage.

TREATMENTS AND DESIGN

Two forms of phosphate:

Sodaphosphate *vs.* superphosphate

combined factorially with three levels of phosphate:

Nil *vs.* equivalent of 50 lb. *vs.* equivalent of 100 lb. available P_2O_5/acre and two levels of liming:

Not limed *vs.* equivalent of four tons ground limestone per acre, in three blocks of four plots. Each plot comprised a single row of 32 rye seeds at ½-in. spacing separated from its neighbours by a tight-fitting vertical steel plate at 7-in. intervals across the wooden boxes measuring 40 in. by 16 in. by 7 in. containing a 5-in. layer of the soil used in the 1950 trials. Each box contained one block of four plots together with a guard row at each end. The ground limestone was thoroughly mixed with the soil before setting in the box; the phosphate was diluted with soil and distributed in a fertilized zone in the same manner as was adopted in the early 1950 trials. The seedlings were cut off at ground level prior to piping and their dry weight per seedling determined.

RESULTS

The soil in all treatments tended to be wet and germination was poor and uneven. The limed plants were stunted and markedly purpled during growth but the unlimed plants made good healthy growth. Mean dry weights in grm. per seedling were:—

	LIMED		UNLIMED	
	Soda	Super	Soda	Super
No Phosphate	0·014		0·031	
Low level phosphate	·012	·011	·053	·043
High level phosphate	·012	·012	·052	·028
Mean	·013		·040	

The results were not subjected to statistical analysis.

The stunting of growth, the development of marked clinical symptoms of phosphate deficiency and the low dry weight per seedling as a result of the lime treatment are of overriding importance and conflict with the results of *Trial* 9/14 on Major Smallwood's farm (in which heavy dressings of ground limestone were associated with some increase in yield of fodder oats).

Harvests were too small for estimation of phosphate uptake to be possible.

Pot culture work, of which adequate records exist, has been confined to investigations into the availability of the phosphate component of superphosphate, sodaphosphate and Uganda rock phosphate. On the other hand, a dearth of information exists on the fertilizing value of Seychelles phosphate (Seychelles guano).

Accordingly, *Trial* 9/7 *of* 1951 which has as its object the examination of the availability of the phosphate content of different fineness grades of Seychelles phosphate in comparison with double supers on a variety of soil types, was initiated.

TREATMENTS AND DESIGN

Four forms of fertilizer:

Double supers (44 per cent citric soluble P_2O_5)
vs. Seychelles phosphate finer than 80 mesh B.S.S. (13.6 per cent citric soluble P_2O_5);
vs. Seychelles phosphate coarser than 80 mesh, finer than 40 mesh B.S.S. (11.3 per cent citric soluble P_2O_5);
vs. Seychelles phosphate coarser than 40 mesh, finer than 20 mesh B.S.S. (8.5 per cent citric soluble P_2O_5);

combined factorially with: four levels of added phosphate:

Nil *vs.* .02 per cent *vs.* .04 per cent *vs.* .08 per cent w/v citric soluble P_2O_5 added, randomized in three replicates of the 16-treatment combination. The culture technique was that described by Gethin Jones (Communication No. 93, p. 2051. Report on the Conférence Africaine des Sols: Goma, 1948). Determinations were carried out on washed sand, and on soils supplied by Messrs. G.B. Farms, Ltd., Njoro, Mr. R. Heape, Bahati, and Mr. J. F. Keppie, Londiani. Yields of dry matter per plant and P_2O_5 uptake per plant were determined in respect of all harvests, the phosphate figures being examined statistically.

RESULTS

YIELDS OF DRY MATTER PER SEEDLING: MGM. PER PLANT

(a) In Sand

	CONCENTRATION OF PHOSPHATE				Mean of Phosphate
Form of Phosphate ..	0	·02%	·04%	·08%	
20–40 Seychelles ..		15	16	17	16
40–80 Seychelles ..		17	17	19	17
80 + Seychelles ..		22	21	22	22
Double Supers		19	18	20	19
Mean ..	16	18	18	20	

(b) In soil ex G.B. Farms Ltd.

	CONCENTRATION OF PHOSPHATE				Mean of Phosphate
Form of Phosphate ..	0	·02%	·04%	·08%	
20–40 Seychelles ..		30	26	30	29
40–80 Seychelles ..		32	29	29	30
80 + Seychelles ..		31	31	31	31
Double supers		29	32	29	30
Mean ..	29	31	30	30	

(c) In soil ex Mr. R. Heape

	CONCENTRATION OF PHOSPHATE				Mean of Phosphate
Form of Phosphate ..	0	·02%	·04%	·08%	
20–40 Seychelles ..		44	39	34	39
40–80 Seychelles ..		35	33	45	37
80 + Seychelles ..		36	36	36	36
Double Supers		35	37	40	37
Mean ..	36	38	36	39	

(d) In soil ex Mr. J. F. Keppie

	CONCENTRATION OF PHOSPHATE				Mean of Phosphate
Form of Phosphate ..	0	·02%	·04%	·08%	
20–40 Seychelles ..		38	38	44	40
40–80 Seychelles ..		37	42	45	41
80 + Seychelles ..		35	41	37	37
Double Supers		33	52	42	43
Mean ..	44	36	43	42	

PHOSPHATE UPTAKE PER SEEDLING: MGM. P_2O_5 PER PLANT

(*a*) *In sand*

	CONCENTRATION OF PHOSPHATE				Mean of Phosphate
Form of Phosphate ..	0	·02%	·04%	·08%	
20–60 Seychelles ..		·140	·194	·209	·181
40–80 Seychelles ..		·140	·183	·208	·173
80 + Seychelles ..		·182	·195	·214	·199
Double supers ..		·320	·402	·499	·407
Mean ..	·184	·195	·241	·282	

Differences were significant (P=0·1 per cent).
Standard error of single treatment combination=·0241.

(*b*) *In soil ex G.B. Farms Ltd.*

	CONCENTRATION OF PHOSPHATE				Mean of Phosphate
Form of Phosphate ..	0	·02%	·04%	·08%	
20–60 Seychelles ..		·542	·421	·641	·535
40–80 Seychelles ..		·618	·548	·805	·657
80 + Seychelles ..		·788	1·015	1·195	·999
Double supers		·598	1·266	1·062	·974
Mean ..	·351	·636	·811	·926	

Differences were significant (P=0·1 per cent).
Standard error of single treatment combination= ·1152.

(*c*) *In soil ex R. Heape*

	CONCENTRATION OF PHOSPHATE				Mean of Phosphate
Form of Phosphate ..	0	·02%	·04%	·08%	
20–40 Seychelles ..		1·178	2·187	·831	1·365
110–80 Seychelles ..		·522	1·480	1·495	1·166
80 + Seychelles ..		0·999	1·759	2·185	1·681
Double supers		1·155	2·307	3·062	2·175
Mean ..	·563	·988	1·933	1·868	

Differences were significant (P= 1 per cent).
Standard error of single treatment combination=·491.

(*d*) *On soil ex J. F. Keppie*

	CONCENTRATION OF PHOSPHATE				Mean of Phosphate
Form of Phosphate ..	0	·02%	·04%	·08%	
20–40 Seychelles ..		·686	·690	·908	·761
40–80 Seychelles ..		·675	1·162	·934	·924
80 + Seychelles ..		·912	1·251	1·023	1·062
Double supers		·918	1·178	1·176	1·091
Mean ..	·362	·798	1·071	1·010	

Differences were significant (P= 0·1 per cent).
Standard error of single treatment combination ·1207.

While according to Gethin Jones' (loc. cit.) criteria, the only medium among these in which phosphate deficiency is apparent is the sand culture, phosphate uptake is in all four trials markedly improved by phosphate application, the magnitude of the improvement being determined partly by the form of phosphate applied and partly by the level at which it is applied.

The phosphate uptake per seedling from the citric soluble phosphate of the coarser (20–40 and 40–80 mesh) grades, but normally not from the finest (80+) grade of Seychelles phosphate is markedly less from all grades of Seychelles phosphate than from superphosphate.

The lowness of efficiency of phosphate uptake from the coarser grades of Seychelles phosphate appears not to be improved relative to that from double supers by increasing the citric soluble phosphate concentration in the medium.

Soil types appear to determine only to a limited extent the efficiency (relative to superphosphate) of uptake of phosphate from the citric soluble phosphate of Seychelles phosphates of varying fineness grades.

Seedling growth, as measured by dry matter per plant at harvest, in all the trials showed little response to phosphate application.

The recorded citric soluble phosphate content of the three grades of Seychelles phosphate are as determined by analysis. Assuming a normal distribution of particle size in each fineness grade (and according to Brass (private communication) the distribution is unlikely to be markedly skew), the total surface area per unit of weight of the three grades will be: 20–40: 40–80: 80+ = 1: 2: 4 +

The citric solubility of the grades as analysed are: 20–40: 40–80: 80+ = 1: 1.33: 1.60.

Neither the citric soluble phosphate content of Seychelles phosphate nor the phosphate uptake per seedling appears directly to depend on the surface area of the particles. The overall relative phosphate uptakes per seedling are: 20–40: 40–80: 80+ = 1 : 1.06: 1.37.

Further examinations of the usefulness of Seychelles phosphate as a fertilizer both by the pot culture technique and by field trials are envisaged.

Lupin Trials

The incorporation of lupins for green manure and fodder in the normal farm programme has been the subject of increasing interest in many parts of Kenya and farmers have imported a wide range of varieties for trial and for use on their farms.

Analysis of a number of samples of these lupins recorded a wide range of alkaloid contents in the types now being grown, the contents revealed in some cases being sufficient for their feeding to constitute a potential poisoning danger to stock. Accordingly, in collaboration with Dr. Thorold of the Veterinary Research Laboratories (who undertake the feeding of the lupins to trial animals), the Assistant Agricultural Officer, Scott Agricultural Laboratories (who grew the lupins), and Messrs. Gates, Heilbuth, Hopley and Rutley, and the Agricultural Officer, Ol Joro Orok (who supplied the seeds of the different varieties tried), *Trial* 11/7 *of* 1951 which had as its object the determination of safe toxicity limits for lupin feeding was undertaken.

The trial combined the feeding of a range of lupin feeds of known alkaloid content to stock with the aim of determining the dosage at which lupinosis symptoms became apparent.

Results

Lupins cut at a preflowering stage having an alkaloid content as high as 0.027 per cent and lupins cut at full flowering stage having an alkaloid content of as high as 0.030 per cent were fed to sheep for 23 days at five times the danger rate of feeding, with no ill effects.

Guinea pigs fed on certain samples of lupin meal containing respectively .104 per cent and "less than .001 per cent" alkaloid consistently lost weight. At the same time, the loss of weight was less consistent on one sample of Sweet Blue Lupin seed with an alkaloid content of "less than .001 per cent".

Most forms of sweet lupin appear safe for feeding provided they are harvested before the crop has set seed. The greatest danger attached to feeding lupins is in the feeding of the seed, particular caution being necessary in the use of this material. The major nutrients in lupins were also estimated; the range of analyses found is quoted later.

Pineapple Studies

Chlorosis and poor growth of pineapples grown on land which had been under previous cropping was causing considerable conceern to growers supplying the canning factory at Thika. The clinical symptoms were indicative of manganese-induced iron deficiency. In collaboration with Mr. C. W. P. Harries, *Trial* 12c/2 *of* 1951, an observation spraying trial was laid down at Karamaini Estate, Thika, using a variety of minor nutrients. Leaves from plants sprayed with dilute aqueous ferrous sulphate and from untreated plants were harvested a month after spraying and examined for the iron content of their dry matter. Some sprayed leaves showed markedly scorched bands, believed due to the spraying; where these occurred, special note was made of the iron content of the segment in which they occurred.

Results

Mean percentage iron as Fe203 in dry matter of latitudinal segments of pineapple leaves from ferrous sulphate sprayed and from untreated leaves:—

	Base 1	2	3	4	5	Tip 6
Untreated	·069	·050	·032	·032	·029	·061
Sprayed Unscorched ..	·071	·044	·058	·055	·079	·109
Scorched Band	—	—	·047	·070	·067	·118

The leaves on plants which have been sprayed with ferrous sulphate showed a higher iron content of their dry matter. At the same time the increase was confined to the tip end of the leaf, the iron content of the dry matter at the base being relatively high even in the unsprayed leaves. Taking the presence of the scorched bands (when they existed) as marking the limit to which coverage of the leaf was effective at time of spraying the detailed data shows the spraying to have raised the iron content of the leaf generally and not to have benefited only the parts of the leaf which actually received spray. Whilst, therefore, new leaves on ferrous sulphate sprayed pineapples may need spraying in order to raise their iron content, a single spraying appears all that is necessary for already grown leaves. There is no indication of higher iron accumulation in the leaf where scorching has occurred after spraying.

A pineapple planting bearing noticeable chlorosis symptoms has been established at Scott Agricultural Laboratories for further examination of the problem.

Soil Surveys

In response to a widely expressed demand *Project* 26/1 *of* 1951 for the formulation of soil maps was initiated, but little progress was possible. Soil surveys during the year were confined to surveys of the Mweia and Ishiara areas of Embu and the Mutunguu–Tharaka area of Meru (in connexion with the possibilities of settlement) and of areas in the Laikipia Plains (in connexion with the threat of bush encroachment), near Kericho (for the Public Works Department Hydraulic Branch in connexion with a proposed forest excision for tea-growing) and near Kitale (in connexion with an investigation into the ecology of star grass).

Weed Killers

A replicated trial under *Project* 35/1 *of* 1951 of the effect of various formulations of 2.4.D. and M.C.P.A. on weed growth in maize which was laid down in the 1950 short rains and which failed with the failure of these rains was replanted with maize in the 1951 long rains, without further weed-killer treatment. Under the dry conditions which prevailed between the time of application of the weed killers and the 1951 long rains season, the ester formulations of 2.4.D. and M.C.P.A. which were under trial ceased to become effective as weed killers, but the weed growth on the sodium M.C.P.A.-treated plots was very much reduced. The difference was scored visually and was found to be very highly significant.

Nitrogen in Rainfall

Determinations of the ammonia nitrogen and (in a few cases) the nitrate nitrogen of rain-water collected at Scott Agricultural Laboratories was continued. Samples were also collected at Matuga (Coast Province), Siriba (Nyanza Province) and Embu (Central Province) and submitted for examination by the local Agricultural Officers and similarly analysed. The results obtained at Scott Agricultural Laboratories from daily collections were as follows:—

	J	F	M	A	M	J	J	A	S	O	N	D
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
Rainfall	·24	·18	4·37	13·25	8·33	7·85	1·64	·96	·07	3·8	5·68	8·61
Ammoniacal N added by rain: lb./acre ..	·030	·025	·647	1·043	·538	·339	·169	·126	·016	·220	1·254	·790

Mean addition of Ammoniacal N in lb. per acre per 1 in. rainfall = .092.

The mean addition per 1 in. of rainfall falls within the range observed in 1950 for samples collected at Scott Agricultural Laboratories, Ol Joro Orok, Kitale and Embu.

An examination was also undertaken of the contamination likely to occur in the monthly collection of rainfall. Contamination was found to be great and to be extremely variable and development of a satisfactory collection technique which will avoid erratic contamination is necessary before the examination of samples from outstations is again undertaken. In view of this contamination, no discussion is given of the results obtained on the samples from Matuga, Siriba and Embu.

COMPOSITION OF PLANT MATERIALS AND STOCKFEED

The building up of a record of the composition of local plant products and other possible stockfeeds analysed at these laboratories was continued, the following being of particular interest:—

Product	Moisture	Crude Protein	Ether Extract	Fibre	Ash	Remarks
Astrologus somoliensis hay	25·0	28·4	1·64	12·3	5·04	
Bambara Groundnut	7·7	18·5	6·04	4·4	3·26	
Bamboo Sticks ..	94·5	1·51	0·19	0·97	0·90	Ash rich in Manganese
Beans	12·7	14·2	1·08	13·0	3·33	
Cashew Nut ..	—	18·7	48·3	—	2·4	
Crocodile Meat Meal	14·8	65·0	12·4		9·11	(Silica 1·86% very fibrous.
Edible Canna Meal	14·6-15·6	3·01-3·03	·17-·33	4·18-7·09		
Silage	68·5-85·1	1·42-1·89	·057-1·06	1·07-3·07	1·59-2·34	
Fish Meal ..	10·4	36·3				
Lucerne Silage ..	73·5	6·51	·932	5·48	3·20	
LUPIN—						
Hay Plants ..	2·75	17·8	1·70	27·9	8·75	
Flowering ..	67·3-75·9	3·35-4·59	·318-·628	5·65-10·2	1·11-2·16	
Preflowering..	33·8-86·0	2·14-10·8	·254-·88	3·24-20·6	2·02-6·02	
Meal	7·3	4·8	1·12	40·5	4·2	
Seed	10·5-13·4	22·0-41·9	3·58-10·2	15·9-16·5	2·46-4·03	
MAIZE (STORED)—						
Clean	13·4	8·09	3·85	2·10	0·98	
Slight weevil infestation ..	13·7	8·97	4·00	2·02	0·93	
Medium weevil infestation ..	13·9	8·94	3·78	1·94	0·95	
Heavy weevil infestation ..	17·2	9·26	1·33	1·89	0·94	
Marrow stem Kale Silage	74·6	3·49	1·19	4·37	1·63	
New Zealand Flax Pulp	83·8	·905	·777	5·49	1·28	1·08% Sugars ·36% P_2O_5 ·45% K_2O 6·4% of dry matter was undecorticated fibre.
Teff Hay	9·74	10·0	1·45	24·9	7·61	

Publications

Nil

Acknowledgments

Among the large number of farmers, business house staffs and Government officials, some of whom are mentioned in this report and to whom I owe a debt of gratitude for their assistance during the year, I would like to make special mention of Mr. R. J. Kempton, on whose shoulders fell much of the burden of running the chemical laboratories during 1951 and the whole burden of their supervision during my absence on vacation leave in the second half of the year, and Mr. J. S. Farrell for his part in the management of the S.A.L. farm under difficult circumstances.

EDWIN BELLIS,
Soil Chemist.

ANNUAL REPORT OF THE SENIOR PLANT BREEDER, 1951

The Season—Wheat, General

The season has been a very wet one. Abnormally heavy falls in April were followed by five months in which rainfall was less than average. The final three months of the year, during which the bulk of the Colony's wheat is harvested, were characterized by excessive and continual rain. 50.32 in. were recorded at Njoro as against an average of 34.92 in. over 21 years. The monthly totals, and the number of days on which rain fell, recorded on this station were as follows:—

Month	Inches	Days	*22 years' Average Inches
January	0·25	3	0·80
February	0·49	6	1·19
March	4·19	12	2·74
April	12·96	25	5·24
May	3·37	18	4·00
June	3·02	14	3·66
July	3·74	15	4·86
August	4·30	20	4·86
September	2·10	12	2·34
October	4·22	23	1·85
November	5·82	18	2·62
December	5·86	19	1·94
*Includes 1951.	50·32	185	36·10

The season has been a poor one for wheat in Kenya. The acreage sown to the crop in the Colony is a record and is estimated to be approximately 301,000 acres, an increase of nearly 37,000 acres, or 14 per cent, over the 1950 total of 264,404 acres. The crop, which earlier promised to be a record one, was seriously damaged by the heavy and continual rains at harvest which led to a high proportion of sprouted grain and greatly reduced yields. The full extent of the damage is not yet known but estimates show that of the total estimated crop of 1,292,000 sacks (4,307,000 bushels) some 14 per cent are unfit for milling. The average overall yield for the Colony is estimated to be 4.29 sacks (14.3 bushels) per acre compared with 5.37 sacks (17.9 bushels) per acre in 1950. The total crop in 1950 amounted to 1,421,744 sacks (4,739,147 bushels)†.

In the Northern Province of Tanganyika some 69,000 sacks (230,000 bushels) are expected from 16,600 acres giving an overal average of 4.14 sacks (13.8 bushels) per acre. This represents an increase of 5,600 acres, or 51 per cent, over the 1950 acreage and compares with the 1950 figure of 80,000 sacks off 11,000 acres or an average of 7.27 sacks (24.2 bushels). The lower yield in the current season is due to stem rust attack, particularly in the Ngare Nairobi area, where many crops were virtually destroyed.

† [Note added in press.] Cereal Actuals issued by the Board of Agriculture show 293,490 acres yielded 1,253,385 sacks, or 4.27 sacks per acre.

The Southern Highlands Province of Tanganyika also experienced a disappointing season the acreage dropping from 3,000 acres in 1950 to roughly half in the present season. The total yield is expected to be about 5,000 sacks or just over three sacks per acre.

Estimates show that during the season over 70 per cent of the acreage under wheat in Kenya and nearly 95 per cent of that in the Northern Province of Tanganyika were sown to varieties produced at Njoro. The remainder is mostly accounted for by introductions made by the Department and released to growers after test.

Review of Main Wheat Varieties Grown

Varieties of wheat grown in the Colony during the season were estimated to be as follows:—

Variety	Acreage
	per cent
Cross 294	31·6
Cross 318	16·4
Sabanero	15·2
1066	9·8
Equator	5·3
360.H	5·0
Rege t	1·3
261	0·9
Unspecified	14·5
	100·0

Cross 294 retains the same percentage of the total as in 1950 due to its good straw, disease resistance and yielding powers over a wide range of soils and altitudes. Although this cross is known to be susceptible to K9, and now also shows susceptibility to the new form K10, it has not been damaged in the field in Kenya. It was, however, severely attacked by stem rust, Form K9, in the Northern Province of Tanganyika.

Cross 318, particularly the strain AJ.4.A.1, has maintained the position it held in 1950 as second in order of popularity and, as forecast in my 1950 Report, has increased in importance, the actual increase being from 12 per cent in 1950 to 16 per cent in acreage this season. It is resistant in seedling tests to the first nine physiologic forms of black stem rust and also shows resistance to K11, a second new form which appeared this season. On account of its stem rust resistance, good straw and yield and its resistance to yellow ear rust, *Puccinia glumarum*, at higher altitudes, it is probable that the acreage to be sown to Cross 318 will show a further increase during the coming season.

Sabanero has also maintained third place from 1950 but the acreage sown to it has risen from 10 per cent last year to 15 per cent this season due to its disease resistance and its reliability over a wide range of conditions. Equator, an old-established yellow rust resistant variety which shared in popularity with Sabanero last year, only accounted for 5 per cent of the acreage this season. Growers have reduced their sowings of this variety as it was quite severely damaged by stem rust last year. Its place in the high areas, where resistance to yellow ear rust is essential, has now largely been taken by Cross 318 and 1066.

1066 occupies fourth place with 10 per cent of the wheat acreage. This is an ear rust resistant variety which has been grown on a small scale in the high country for many years past but never attained much popularity in competition with Equator. The decline in importance of Equator, due to stem rust attack, has enabled 1066 to take its place.

Regent, a hard red Canadian spring wheat, which was very popular with farmers a few years back, was again bady attacked by yellow ear rust last season and has, as expected, declined severely in acreage. From first place in 1949, with 30 per cent of the acreage to its credit, it dropped to fifth place with 10 per cent of the acreage last season and this year only 1 per cent of the acreage has been sown to it. This provides a good example of the virtual eclipse, in the short space of two seasons, of a popular and valuable variety due to rust attack.

In the Northern Province of Tanganyika, Cross 294 proved the most popular wheat with 46 per cent of the total acreage. It was followed by Cross 261, 25 per cent, and Kenya Governor, 10 per cent. In this area, quick-, rather than long-, maturing wheats are required, owing to the short season, and the above three varieties satisfy these conditions.

Rust and Other Diseases

Little black stem rust, *Puccinia graminis tritici,* was seen in Kenya but in Tanganyika, as has already been remarked, stem rust attack was severe in the Northern Province and led to reduced yields. All the commonly grown varieties, including Cross 294, were attacked; the only varieties which remained free from rust, or were very lightly attacked, were Crosses 318 and 184, neither of which was grown on any appreciable scale. A survey showed the most prevalent form in Kenya and in the Northern Province of Tanganyika to be K9 with the older forms K1 and K5 occurring occasionally. This is exactly the position which obtained in 1950. In addition two new forms, K10 and K11, appeared; both were found in Kenya whilst K11 was suspected but not confirmed in Tanganyika.

Leaf rust, *Puccinia triticina,* was fairly common in the lower wheat areas but attacks were not severe and little effect on yield is expected. A great deal of yellowing and die-back of the foliage was observed, especially in the Endebess area of the Trans Nzoia, probably caused by *Helminthosporium sativum,* not commonly seen in Kenya. This disease led to a considerable loss of foliage and yield would be appreciably affected.

Take-all, *Ophiobolus graminis,* was much in evidence in the higher areas over 8,000 ft., particularly on soils which had been growing wheat for a number of years in succession without rotation. Under such conditions very severe damage to the crop occurred.

Glume blotch, *Septoria nodorum,* was more prevalent due to the wet season and particularly affected Cross 318 which seems very susceptible to it. This susceptibility has been remarked upon in the past.

Physiological Forms of Black Stem Rust—Appearance of Two New Forms

Two new physiological forms of black stem rust appeared during the season. They make the 10th and 11th forms to be found in East Africa and they have been designated accordingly K10 and K11. K10 was isolated in Kenya from rusted 360.H in the Kipsigis native wheat trials at Kapkatet. It was the sole occurrence of K10 in the Colony. K11 was isolated from Kenya Settler and 360.H on the Kinangop Plateau and from 117.A, 294.M.7.C.6.A and Cross 362 on the Government Farm at Ol Joro Orok. 362 is a new cross (Equator x 294.M.7.C.6.C) under multiplication for larger scale trials. In Tanganyika K11 was suspected, but not confirmed, on 294.B.2.A.3 and 294.M.7.C.6.A from the Moulu Development Farm in the Northern Province. K10 was not found in Tanganyika.

The following table shows the reactions so far worked out in seedling tests of a number of wheats to these two new forms. Tests are continuing: —

	K10	*K11*
Cross 294	S	S
Cross 318	R	R
Sabanero	S	S
1066	?	S
Equator	R	R
Regent 975.6	S	S
360.H	R	R
117.A	R	S

The appearance of two new rust forms again complicates the task of recommending to the farming community suitable varieties for growing. Advice has been published in the local Press embodying the above information and offering suggestions with the rust position in mind. It seems likely that owing to its susceptibility to K9 and K10, and its attack on a field scale in Tanganyika during the season, there may be some reduction in acreage sown to Cross 294 during the coming year. On the other hand, the continued resistance of Cross 318 in the field may lead to an increase in acreage sown to this wheat.

351.AS.1.B.2, a new variety resistant in seedling tests to all 11 physiologic forms of black stem rust and under multiplication with a local farmer, rusted in the field and a twelfth form is now suspected. This is at present the subject of test.

Form K10 shows susceptible reactions on the testers 112.A, B.256.G, and 58; resistant reactions on Kenya Governor and Reliance; and border-line reactions on Einkorn. Form K11 shows susceptible reactions on the testers 58 and 112A; and resistant reactions on the remainder. These reactions serve to distinguish these two new rusts from the older forms.

Release of New Wheats

One new wheat was released to farmers from Departmental control for sowing in 1952.

Wheat No. 321.BT.1.B.1 (Australian 45.C.5 x 117.A)

321 is a beardless, white-chaffed, white-grained variety of mid-season maturity, fair straw strength and moderate baking quality. Seedling tests show it to be resistant to K1 to K7 and to K11, and susceptible to K8 and K9. Tests with K10 are still in progress*. The variety has not been attacked by stem rust in the field. 321 has done moderately well on a field scale at Solai, Njoro and in the Moiben Valley, and should be suited to all areas of the Colony from 6,000–7,500 ft. having a growing season of 5½ months' duration.

321 is a variety of moderate-yielding powers only. It was developed some years ago but was never released since it appeared to offer no advantages over varieties already in cultivation. However, several new physiologic forms of black stem rust have arisen within the last two years to which 294.M in particular, and other varieties, are susceptible. 321, although susceptible to some stem rust forms in seedling tests, has not been attacked in the field and as it is felt it may prove of value to the Colony on this account it has been decided to proceed with its release.

* Susceptibility to K10 since confirmed.

New Wheats under Multiplication with Farmers

As forecast in the 1950 Report, further multiplication of the five wheats 338.AC.2.E.1, 294.H.2.A.1, the bearded 291 selection 291.J.1.I.1.I.1, 355.AZ.1 and Newthatch (C.1.12318), has been abandoned either because of rust susceptibility or because they appeared to offer no advantages over varieties already in production.

351.AS.1.B.2, which had shown itself resistant in seedling tests to all 11 physiologic forms of stem rust, suddenly rusted on a field scale and a further new rust form is suspected. This is being tested but the further multiplication of this variety will now have to be abandoned.

321.BT.1.B.1, although susceptible in seedling tests to K8 and K9, has not been attacked in the field and has accordingly been released as explained earlier.

The two rust-free D.C. x Ceres selections, R.46 and R.64, chosen from the original four selections, and the durum variety Carleton, C.I.12064, were multiplied a stage further. All three wheats have shown themselves resistant to K11 in seedling tests and the two D.C. x Ceres selections are resistant to K10.

Wheat-breeding at the Plant Breeding Station, 7,100 ft., and the Rongai Sub-station, 6,000 ft.

IMPORTATIONS

The following trials were carried out at the Plant Breeding Station unless otherwise stated. Owing to the unfavourable season it was difficult to obtain reliable observations.

1949 Importations

From S. Rhodesia.—Of the original 61 varieties imported, all except one, Granadero Klein, have been discarded for various reasons. This variety was only slightly attacked by stem rust in the field during the season and it has been multiplied further for larger scale tests in 1952. It grew well and gave grain of 64½ lb. per bushel at Rongai.

Although a weak wheat, Granadero Klein shows extremely distensible properties and has been used as a parent in crosses for this reason.

From Potchefstroom, S. Africa.—Both 466–4.M.M.3 and 361.M.4.1 out of the original six *T. vulgare* x *T. timopheevi* crosses were further multiplied. Both remained free from stem rust but were attacked by leaf rust and browning of the lower foliage. One, 361.M.4.1, was put in the yield trial at Njoro where it came 14th out of 25 entries.

From the Ministry of Agriculture, Orman, Egypt.—Mukhtar and Giza, which proved disappointing in 1950 at Njoro and Molo, were tried at the low-altitude sub-station at Rongai. They were very slightly attacked by stem rust with pustules of the "R" type and quite severely by leaf and yellow rusts on the foliage. Giza proved better than Mukhtar. They gave grain of bushel weights 62½ lb. and 61 lb. respectively. Both will be carried on to further multiplication plots during the coming season.

From the Dominion Laboratory of Cereal Breeding, Manitoba, Canada.—The varieties carried on from 1950 suffered badly due to the wet season. R.L. Nos. 2150, 220, 2477 and 3047 remained free from stem rust; 1742 and 3048 were slightly attacked and R.L. 2327.5 (R.L. 2265 x Redman[3]) suffered severely from stem rust with pustules of the "S" type and will have to be discarded.

At Rongai, Hope x Timstein (R.L. 2477) proved outstanding and although slightly attacked by stem rust it remained free from leaf rust and gave grain bushelling 63½ lb. R.L. Nos. 3047 and 2150 at Rongai were attacked by leaf rust and browning of the foliage and do not look heavy yielders.

All except R.L. 2327.5 will be carried on to larger scale tests in 1952.

From Estaquo de Melhoramento de Plantas, Elvas, Portugal.—The two durums, Argelino 10990 and Russo 8683, carried on from 1950 grew well at Njoro and proved extremely vigorous and of considerable straw strength though rather tall. Both looked promising early on but were attacked by stem rust before harvest.

They will be carried on to field scale multiplication trials in 1952.

1950 Importations

From the Dominion Cerealist, Ottawa, Canada.—Hope x Timstein C.A.N. 3751, and Mida x Cadet C.A.N. 3668, were carried on from 1950. The first lodged badly and was attacked by yellow rust on the foliage. Mida x Cadet remained free from stem rust. It stood well, although rather tall, and gave good grain of 61 lb. bushel weight.

Both will be carried on to larger trials in 1952.

From the Waite Agricultural Research Institute, Adelaide, Australia.—Of the four wheats received in 1950, Glenwari was slightly attacked by stem rust of the "R-S" type. Nabawa x (Riverina x Hope), strain 38–356, remained from from stem rust but suffered yellow leaf rust and blotch, *Septoria nodorum.*

Both will be tried again in 1952.

Dirk 48 and Javelin grew poorly and were badly rusted. They will be discarded.

From the Department of Agriculture, Perth, W. Australia.—Both Wongoondy and Dowerin were discarded for poor growth and rust susceptibility.

From the United States Department of Agriculture, Washington, D.C.—Rio Negro, and Newthatch x Timstein II-42-22 remained free of stem rust; Timstein, Klein Titan, II-39-46 (Minn 2776) and Premier x Bobin^2 – Gaza II-39-2 were slightly affected.

Timstein and Newthatch x Timstein suffered yellow rust attack on the foliage, the latter badly, and Klein Titan had 5–10 per cent of the florets affected by the same rust.

All suffered badly from the weather and will be again tried in 1952.

1951 Importations

The following wheats were on trial for the first time. All were badly affected by the wet harvest, making comparison difficult.

From Wellington, New Zealand.—Hilgendorf, Cross 7, College Hunters, Tainui, Solid Straw Tuscan, Fife Tuscan and Jambuck. All were badly attacked by stem rust, the last four setting no seed.

From the College of Agriculture, Potchefstroom, S. Africa.—Forty-one selections from *T. vulgare* x *T. Timopheevi* crosses. They showed varying reactions to stem, leaf and yellow rusts and a number remained free of disease. Further trials will be carried out in 1952.

From the Ministry of Agriculture, Buenos Aires, Argentine.—Twelve varieties as follows: La Prevision, Klein Aniversario, Buck Quequen, Klein Cometa, Benvenuto Inca, Klein Lucero, Klein Credito, Klein otto Wolff, Barletta 10, Klein Orgullo, 38MA, Sinvalocho MA and Klein Titan. Most were attacked by stem rust and the best will be carried on.

From U.N.E.S.C.O., East Asia Science Co-operation Office, Shanghai, China.—Nine varieties, Pi Yu (Quality), Nanking, and Western Agriculture Nos. 1, 2, 3116, 3120, 3162, 6028 and 10177.

All were attacked by rust to a varying degree and, except the first named, set no seed.

From the Senior Cereal Geneticist, Werribee, Victoria, Australia.—The 18 varieties Quadrat, Gurkha, Pindar, Pinnacle, Magnet, Ranee, Regalia, Insignia, Mogul, Sepoy, Major, Free Gallipoli, Currawa, Dundee, Bencubbin, Ford, Nabawa, Baldmin. All had excellent short straws but were severely attacked by stem rust with pustules of the "S" type and set little or no seed. Selected varieties have been used as parents in an attempt to shorten and strengthen the straw of Kenya wheats.

From the Director of the Institute of Plant Industry, Indore, India.—Eight varieties, Rewa 41, Bansi 165, Hyd 557–10, Bombay 224, P.B.1, P.B.3, E69 and Malvi Local. All were covered at an early stage with yellow rust pustules on the foliage and were completely destroyed before coming into ear.

From Dr. R. F. Peterson, Dominion Laboratory of Cereal Breeding, University of Manitoba, Canada.—Iumillo x Mindum R.L. 1317 and 1642, Exchange R.L. 1803, Chinese R.L. 1815, Klein – 33 R.L. 1885, and Illinois No. 1 B8 R.L. 1593. All except the last two remained free from stem rust. The Iumillo-Mindum crosses were attacked to varying degrees by yellow rust on the foliage; Exchange and Illinois suffered from browning and spotting of foliage. Chinese remained completely free from disease.

From the Indian Agricultural Research Institute, New Delhi.—N.P. 710, 718, 737, 740, 760 and E.C.729. All looked most promising early on but were covered at harvest with stem rust pustules of the "S" type.

From the College of Agriculture, Bombay, India.— Nos. 113, 116 and 197. All remained free of stem rust but suffered some yellow rust attack and browning of the leaves.

From the Wheat Research Station, Hosangabad, India.—Hybrid Nos. 1–8. All were attacked by yellow leaf rust and the foliage destroyed. In addition a number also suffered stem rust attack. No. 1 had excellent straw.

Cage Material

The 44 crosses made in 1950 were planted out as F.1 material. Selection was continued in the crosses 372–392, listed in the 1948 Annual Report, which have now advanced to F.3. Selected F.4 material from the crosses 363–367 (Warigo x 261 and 184) was promoted to the small multiplication plots. The *Triticum timococcum* x Marquis, Regent, and Newthatch back-crosses were again crossed to selected parents. The programme of back-crossing started in 1948, with the object of transferring from one parent to a second otherwise desirable variety a single character which it lacks, was continued.

One hundred and fifty new crosses were made, using local wheats and promising importations, and 74 back-crosses in continuation of the 1948/50 programme. These will not be listed here, as has been customary in earlier reports, owing to considerations of space. The number of seeds set in these crosses was 5,182 out of a possible total of 10,385, giving a set of 49.9 per cent.

Wheats Under Multiplication

Selected segregates from the crosses 354 (Warigo x Sterling), 356 (184.P.2.A.1.F x 192.Q.2.A.L), 357 (184.P.2.A.1.E x 294.AN.4.A.1), 358 (184.P.2.A.1.E x 294.B.2.A.3), 359 (291.J.1.I.1 x 184.P.2.A.1.E), and 360 (294.M.7.C.6.C x 184.P.2.A.1.E) were further multiplied and tested in yield trials.

In addition, selected cage material from the following crosses which had reached apparent fixity was promoted to the first multiplication stage—cross 362 (Equator x 294.M.7.C.6.C.), cross 363 (Warigo x 261.S.10.C.2.D), cross 364 (Warigo x 261.S.10.C.1.A), cross 365 (Warigo x 261.R.7.C.1.B), and cross 367 (Warigo x 184.P.2.A.1.F).

The following selected importations, which had shown promise in the 1950 small plot trials, were further multiplied: Granadero Klein from S. Rhodesia; 361.M.4.1 and 466-4.M.M.3 from South Africa; Marquis[2] x *A. elongatum* R.L. 2150 and 2200, Bald Medeah x (Iumillo-Mindum) R.L. 1742, R.L. 1742 x Carleton[2] R.L. 3047 and 3048, Hope x Timstein C.A.N. 3751, and Mida x Cadet C.A.N. 3668 from Canada: Mukhtar and Giza from Egypt; and Russo and Argelino from Portugal.

YIELDS OF NEW WHEATS UNDER TRIAL

The following table gives yields of some of the newer hybrids at Njoro, 7,100 ft., and at Rongai, 6,000 ft., in comparison with some introductions. It is interesting to note the general high-yielding level of cross 360; all the selections have out-yielded, some significantly, the newly released 360.H. This is rather a different picture from that given in the 1950 trials, when 360.H headed the list at Njoro, and emphasizes the need for yield trials to run over several years to even out seasonal effects.

The low yields at Rongai are due to lack of fertilizer application.

YIELD: (BAGS OF 200 LB. NET PER ACRE)

Variety	Njoro	Variety	Rongai
360.F.8.D.3	9·48	261.E	3·78
360.E.13.C.7.D	9·44	261.D	3.77
360.E.13.C.7	8·65	351.AS.1.B.2	3·75
360.E.13.C.7.H	8·64	261.Y	3·70
360.G.1.B.3	8·43	338.AA.1.A.2	3·55
360.E.13.C.7.G	8·08	261.G	3·52
357.P.2.B.1	8·07	360.H	3·49
354.P.3.D.3	8·05	117.A	3·35
359.AV.1.B.1.A	8·03	184.P.2.A.1.A	3·21
360.E.13.D.1.B	7·94	Redman	2·86
360.H.3	7·72	L.D.111	2·30
360.G.1.B.1	7·62	L.D.101	2·22
360.G.1.B.2	7·41	L.D.119	2·03
361.M.4.1	7·32	L.D.128	1·91
360.H	7·22	Carleton	1·77
357.AB.1.D.1	7·17	L.D.104	1·68
357.AB.1.D.7	7·13		
357.AB.1.D.10	7·07		
357.AL.1.B.7	7·02		
359.C.1.D.3	6·96		
354.P.3.D.4	6·77		
D.C. x Ceres	6·70		
R.L.2265 x Redman[3]	4·41		
D.C. x Ceres R.46	4·40		
D.C. x Ceres R.64	4·25		
Average yield	7·35		2·93
Significant Differences—			
P.05=	1·30		0·60
P.01=	1·73		0·80

Wheat-breeding at the High- and Low-altitude Sub-stations

SCOTT AGRICULTURAL LABORATORIES, 5,700 FT.

No wheat-breeding work was done at this sub-station during the season.

MOLO SUB-STATION, 9,300 FT., AND OL JORO OROK, 7,800 FT.

The aim of the high-altitude breeding work is to obtain varieties of good-yielding power suited to the longer season conditions which obtain in the areas over 7,000 ft. Resistance to yellow ear rust, *Puccinia glumarum*, is essential.

In the Molo cage, selection continued in the crosses 384 (Equator II x Kenya Ploughman) and 385 (Equator II x 318.AJ.4.A.1) which have now advanced to F.2. They have as their object the combination of the high yield and straw qualities of cross 318 with the vigour and yellow rust resistance of Equator. These crosses were transferred this season to the high-altitude station at Molo which provides a severe test for yellow rust reactions; and further selection was based on resistance to this rust coupled with shortness of straw. There is definite need of a high-yielding, short-strawed, yellow rust resistant variety for growing in the high-altitude areas over 8,500 ft. to replace the weak-strawed, stem rust susceptible, Equator, and the low-quality 1066 which virtually dominate these areas at the present time. Recent breeding work has produced the three varieties 337, 341 and 350, released to farmers last season: and the crosses 384 and 385 show promise of yielding some useful material.

Single plant selections within the varieties 318, 1066, Equator and D.C. x Ceres, made in 1949 in an attempt to improve straw strength and yellow ear rust resistance, were sown in small multiplication plots for further study. Selected segregates in the crosses 361 (Equator x 117.A) and 362 (Equator x 294.M.7.C.6.C) were promoted from the cage to the first multiplication series and were under observation both at Molo and Ol Joro Orok.

Results of the season's yield trials are:—

YIELD: (BAGS OF 200 LB. NET PER ACRE)

Variety	Molo	Variety	Ol Joro Orok
318.AJ.4.A.1	5·65	350.AD.9.C.2	13·00
Equator II	3·21	360.H	11·90
350.AJ.3.A.2	3·00	337.BE.2.F.2	10·20
360.H	2·87	294.M.7.C.6.A	10·00
362.B.1.E.4	2·87	337.V.3.B.1	9·49
362.A.1.D.1	2·71	318.O.3.B.2	9·44
362.B.1.A.4	2·54	318.AJ.4.A.1	9·34
362.B.1.A.1	2·36	341.F.2.D.2	9·20
350.AJ.3.C.2	2·11	337.V.1.B.1	8·65
337.BE.2.F.2	2·00	Ceres R.46	8·61
350.AJ.3.A.1	1·99	Ceres R.64	6·63
362.B.1.A.3	1·97	Ceres Control	5·69
350.AJ.3.C.1	1·92		
362.B.1.A.2	1·86		
350.AD.9.B.1	1·25		
337.V.3.B.1	1·09		
Average yield	2·46		9·35
Significant Differences—			
P.05=	0·65		2·30
P.01=	0·86		3·02

Low yields at Molo are due to the excessively wet season, leading to poor growth and considerable loss of yield by sprouting. 318.AJ.4.A.1 has yielded significantly higher ($P<.01$) than the remainder, followed by Equator II. The remaining wheats, being quicker-maturing varieties, suffered particularly severely from the weather and little value can be placed on this year's results.

At Ol Joro Orok, 350.AD.9.C.2 heads the list and shows itself significantly better ($P<.05$) than all the remainder with the exception of 360.H. There is no difference in yield between the two D.C. x Ceres selections, as was the case in the 1950 trials, but R.46 has significantly out-yielded the parent ($P<.05$). It is interesting to note the good performance of 360.H at both centres.

Baking Quality and Fermentation Tests

Samples of all advanced hybrids and wheats undergoing multiplication for possible release to farmers are tested for milling and baking quality by the courtesy of the Kenya millers, Messrs. Unga Ltd., Nairobi.

Pelschenke Wholemeal Fermentation Tests are also carried out as a routine measure on all new hybrids.

Barley

The wet season has been a good one for malting barley and some excellent plump and mealy samples, low in nitrogen, have been received by the maltsters. Research, the two-row Australian variety received from the State Research Farm, Victoria, and released to farmers in Kenya in 1948 continues to be the most popular variety, and again won the East African Breweries' Malting Barley Competition for the best sample of barley of malting quality produced in the Colony. Prior, also a two-row Australian variety and one of the parents of Research, continues second in order of acreage but is not so popular as Research on account of its weaker straw. Plumage Archer is grown to a limited extent in the high country but is not so popular as the Australian varieties on account of its, generally, lower yields.

In the lower areas, below 7,000 ft., Glacier, a six-row variety from the U.S.A., is proving slightly superior to Canadian Mariout in yielding powers and is becoming increasingly grown. It has good straw and stands well.

Yield Trials

The yield trial at Molo was a failure due to the excessively wet season which has also been responsible for the low yields at other centres. Results of the trials at Njoro, Rongai, and Ol Joro Orok follow:—

Yield: (Bags of 180 lb. Net per Acre)

Variety	Njoro	Rongai	Variety	Ol Joro Orok
Glacier	11·30	5·95	Golden Archer ..	6·40
Velvon	11·12	6·18	Research	6·10
Sanalta	8·21		Abed Kenia	5·23
Ymer	8·01		Spratt Archer	5·15
Plush	7·87		Hannchen	3·73
Wisconsin	7·82		Ray	2·99
Tregal	7·63	4·53	Chevron	2·97
Rex	7·20		Trebi	2·69
Chevron	7·10	2·12	Colville	2·21
Peatland	6·67	2·33	Peatland	1·92
Compana	6·61	5·14	Plumage Archer ..	1·50
Mars	6·59			
Hannchen	6·52	4·93		
Trebi	6·17			
Prior	5·82			
Vantage	4·99			
Average yield ..	7·48	4·43		3·72
Significant Differences				
P.05=	1·19	0·90		1·23
P.01=	1·58	1·19		1·62

At Njoro and Rongai, Glacier and Velvon, both American varieties, have yielded significantly higher than the remainder ($P < .01$). Many of the American varieties have yielded well in comparison with the standard Prior. Ymer, a short-strawed, two-row Scandinavian barley which topped the Njoro yield trial in 1950, has again proved successful and is being multiplied up for larger scale trials in 1952. Compana, Hannchen and Trebi, which did well at Njoro in 1950, have not kept up their initial promise in the wetter year and this again stresses the need for trials to run over several years.

At Ol Joro Orok, Golden Archer and Research, both of which did well in the 1951 trial, again head the list, the former significantly better in yield ($P < .05$) than all except Abed Kenia. Abed Kenia has yielded consistently well over a three-year period at Ol Joro Orok and is being multiplied up for field-scale tests in 1952. The general low level of yields at Ol Joro Orok is due to the wet season.

New Varieties Under Multiplication with Farmers

As a result of the 1950 yield trials stock seed of Abed Kenia and Ymer, short-strawed, two-row Scandinavian malting varieties, and Hannchen, a two-row variety from the U.S.A., were issued to farmers for multiplication under Departmental control. Peatland, which proved outstanding in the 1950 observation plots, was also multiplied.

Trials at Kitale

Trials continued with the object of finding a barley which will grow satisfactorily on the light red soils of the Trans Nzoia district. Successful barley production would enable a break-away from maize monoculture, which still obtains over a large part of the area, and would enable an improved rotation to be worked out.

A yield trial of five varieties gave the following result. Seed was broadcast at 100 lb. per acre with a dressing of 75 lb. per acre of double superphosphate:—

Yield: (Bags of 180 lb. per Acre)

Variety	
Research	4·98
German	3·73
Glacier	3·70
Prior	2·82
Abyssinia	1·48
Average yield	3·34
Significant Differences—	
P.05=	1·24
P.01=	1·69

Research has again proved its value by out-yielding the remaining varieties ($P < .05$) and shows promise of being a suitable variety for the area. For success, any variety must be capable of competing with weed growth which is usually heavy on these soils; inability to grow away from weeds may mean that a variety, successful in other respects, is quickly smothered.

In addition to the yield trial, 19 American varieties were sown in observation plots. The most promising were Wisconsin, Sanalta, Velvon, Hannchen and Trebi, in that order, and these will be tested in larger plots and in a yield trial in 1952. Again, these varieties produced an early good ground cover and were successful in suppressing weed growth.

Observation Plots at Ol Joro Orok and Naro Moru

At Ol Joro Orok, 17 barleys were sown in observation plots with the object of selecting those showing most promise for further study. Due, however, to lack of phosphate application all germinated badly and grew very poorly so that little value can be placed upon the results.

A second series of observation plots was laid down at Naro Moru in a preliminary trial with the object of finding a variety which might be successful in the short-season, cool, conditions of the area. Thirty-one barleys were under study consisting of varieties from America and South Africa together with the Scandinavian Ymer and Abed Kenia, Plumage and Spratt Archer, and the standard varieties Research, Prior and Glacier. The season in the area, which is usually considered to be marginal for crop production owing to low rainfall, proved very favourable and most of the varieties grew well. Those showing most promise were Vantage, Abed Kenia, Newal and Glacier with Trebi and Ymer closely behind. Further trials are to be undertaken in 1952.

Importations

No hybridization work has so far been carried out with barley, and the programme has as its aim the introduction and testing of varieties for suitability to the various altitude ranges over which the crop is grown. Unlike wheat, introduced varieties of which are commonly severely attacked and often destroyed by rust, introduced barley varieties are often quite successful in Kenya as is shown by the popularity of the Australian varieties, Research and Prior, and the American feed variety, Glacier.

The following trials of new introductions were carried out on the Plant Breeding Station, unless otherwise stated:—

1949 Importations

From Iraq.—All three varieties carried on from earlier trials, Trabout H231, Californian Chevalier H236 and Chilean 2-R H160 made terrific growth and went flat before harvest. The first named seemed the most promising and will be multiplied on a field scale in 1952.

From the Ministry of Agriculture, Orman, Egypt.—Beladi 16, noted as having short straw in 1951, stood well in spite of the heavy rains. It appears of promise and will be further increased during the coming season.

From S. Rhodesia.—Blue barley proved again an aggressive grower but it lodged before harvest. It will be multiplied on a field scale in the Rongai area in 1952 owing to its susceptibility to yellow rust at Njoro. Trabout and the naked variety, Black barley, will be carried on to further multiplication in 1952.

From Cyprus.—The two barleys remaining from the 1950 trials, Beladi and Paphitico, again made poor growth and will be discarded.

From Potchefstroom, South Africa.—Both Elses and Swanneck made rather poor growth. The latter proved to have weak straw and lodged. Both will be given further trial.

From Estado de Melhoramento de Plantas, Elvas, Portugal.—The barleys 4236, 4242, 4246, and 4261 selected from the 1950 season were on further trial. All proved of poor growth and did not live up to their initial promise. The first-named was the best.

1950 Importations

From the Plant Breeding Institute, Cambridge.—The early-maturing selection from Spratt Archer, Earl, proved to have weak straw and lodged. It will be given further trial.

From the Department of Agriculture, Victoria, Australia.—All four barleys, Cape, Sea of Azov, Vaughn, and Atlas, looked promising early on. Cape and Sea of Azov lodged before harvest. The latter two had better straws and were standing at harvest but they were badly attacked by leaf rust and the foliage destroyed.

1951 Importations

The following introductions were on trial for the first time:—

From the Swiss Experimental Station for Agriculture, Zürich-Oerlikon.—Adliker 9, Kloster Disentis 29, and Riniker 3. All lodged.

From the Ministry of Agriculture, Buenos Aires, Argentine.—La Estanzuela 75A and 702, Monte Cristo, Anoidium 35.4 and 35.5, Engeldow India, La Prevision 19, Vaughn (Sel. guatrache), Klein Bb 5.100 and 7.500, Flint Smooth (Sel. guatrache), Buck 42, and De Hoyo Epuyen. All were badly affected by the weather but the last-named three showed fair promise.

From the Institute for Research on Varieties of Field Crops, Wageningen, Holland.—Mansholt's two-row, Golden, Balder, and Agio. All lodged. The first-named seemed the best.

From Instituto Agronomico, Brazil, S. America.—Cervejeira, Tipo C35, 36 and 37, Ipanema, Continental, Saxonia, Goudgerst, Balder, Boldew, and Bigo. Germination was very poor and some varieties failed to germinate.

From the Department of Agriculture, Dublin, Eire.—Balder, Maja, Bonus, Heimdal, Rigel, Binder, Ymer, Carlsberg, Kenia, Rika, Earl, Herta, Humes Archer, Spratt Archer x Spratt 2/9, Spratt Archer x Archer 2/4, 20, 23, and 30, Spratt x Archer 1/3, 1/11, 45, 74, and 77, Spratt Archer 37 No. 3, and Kenia x Spratt Archer x Kenia. All lodged and will be tested further in 1952.

Oats

No breeding work with oats has so far been found possible and the programme, as with barley, aims at testing introduced varieties. As with wheat, most introductions, particularly those from Europe, are too susceptible to rust to be released to growers. Certain Canadian varieties mentioned in the 1949 Report, R.L. 1710 and 1734, and a few introductions from America, appear to have some resistance but, nevertheless, are attacked to a varying degree and must probably be considered too susceptible for general cultivation in Kenya. Some of the more promising introductions are being bulked for larger-scale tests. There is undoubtedly need for an oat-breeding programme in Kenya, aimed at the production of high-yielding, strong-strawed, feed and milling varieties, resistant to disease, particularly stem and crown rusts (*Puccinia coronata*). Such a project will, however, have to await extra staff.

Lampton, from Australia, still remains the standard for hay and feed with Grey Algerian as the recognized milling variety, particularly over 7,500 ft. in which areas the plumpest samples are produced.

IMPORTATIONS

The following importations were tested on the Plant Breeding Station:—

1950 Importations

From the U.S.D.A., Beltville, Maryland.—In 1950, the five varieties Mohawk, C.I. 4327; Bannock, C.I. 2592; Victory, C.I. 560; Valor, C.I. 4137; and Fortune, C.I. 5226; were all attacked by stem rust but remained free of crown rust. During the present season Mohawk and Valor were covered with stem rust but suffered no crown rust attack, whilst the remainder were destroyed by crown rust and set no seed but remained free of stem rust. It would appear, therefore, that there is more than one form of oat stem rust in existence in Kenya.

From the Department of Agriculture, Melbourne, Australia.—In 1950, Mulga, Early Kherson, Early Baart, and Palestine, were badly attacked by stem rust: New Zealand Cape, Belar, Guyra, and Orient, had a lighter attack. During the present season Early Kherson remained free of stem rust, thus adding weight to the likelihood of more than one stem rust form, but was quite severely attacked by crown rust. Mulga, New Zealand Cape, Early Baart, Belar, Orient, and Palestine, were all badly attacked by stem rust, the last-named setting no seed. Guyra had a lighter attack. The harvested grain of all varieties was composed mainly of husk and weighed from 12 lb. to 20 lb. per bushel.

From the Dominion Cerealist, Ottawa, Canada.—Ajax 1948, Beaver 1948, Beacon 1948, Garry 1948, and 3003.F 1948. All had no crown rust infection in 1950 and were little attacked by stem rust. In the present season the first three were badly attacked by stem rust, suffered only slight crown rust infection, and gave grain bushelling 15 lb. to 20 lb. in weight. Both Garry and 3003.F remained free of crown rust and had only a light stem rust infection. The last named seemed of greater promise than the remainder and will be increased in 1952.

From the Senior Cerealist, Ottawa, Canada.—Larain was badly attacked and destroyed by crown rust. It had only slight stem rust attack. Roxton, a later variety, grew very lush and had only slight stem and crown rust attack. It lodged badly before harvest.

From the State Research Farm, Werribee, Victoria, Australia.—Algeribee remained free of stem rust but was destroyed by crown rust and set no grain.

1951 Importations

The following introductions were on trial for the first time:—

From Iowa State College, Ames, Iowa.—Clinton, Benton, Eaton, Bonda, and Mindo. All remained free of crown rust except Mindo which was only slightly attacked. The first three suffered fairly severe stem rust attack with pustules of the "R-S" type; the latter two had a slighter infection. Mindo had short straw; the remainder grew very vigorously and tended to lodge at harvest.

From Dr. C. H. Goulden, Dominion Experiment Farm, Ottawa, Canada.—Beaver, which grew very vigorously and was mildly attacked by stem and crown rusts which seemed to have little effect on its general growth and grain quality.

From the Swiss Experimental Station for Agriculture, Zürich-Oerlikon.—Rosegg 2 and Adliker 9. Both grew well and were only slightly attacked by stem and crown rusts. The heads produced were small and contained little grain.

From the Senior Cereal Geneticist, Werribee, Victoria, Australia.—Algeribee, Sunrise, Palestine, Dawn, and Orient. All were severely attacked by stem rust, the last three named setting no seed.

From Minnesota Agricultural Experiment Station, Minnesota, U.S.A.—Hajira-Joanette; Victoria x Hajira-Joanette; Landhafer x (Mindo x Hajira-Joanette); Mindo x (Hajira-Joanette) x Landhafer; (Hajira-Joanette x Bond-Rainbow) x Santa Fe 0-200-7; Hajira Joanette x Bonda-Rainbow; Bonda, Mindo, and Andrew. All grew vigorously and remained free of rust or had a mild infection only. The Santa Fe cross 0-200-7 suffered more severe crown rust attack.

These introductions seem of promise and will be carried into larger observation and multiplication plots in 1952.

Observation Plots at Ol Joro Orok and Kitale

The following 12 varieties were under study in observation plots at Ol Joro Orok: Victory, Exeter, S.E.S.387, Boone, Fultex, Ajax, and R.L. Nos. 1674, 1681, 1692, 1694, 1710, and 1734. The first two named were severely attacked by crown rust, the third by stem rust, and were badly damaged. The remainder suffered slighter attack and the best will be tested in a yield trial in 1952.

At Kitale the object of the oat trials is the same as that of the barley trials—to find an alternative crop to maize; and for this purpose a good hay or grain variety is required which will grow successfully on the light, sandy loams of the area. Four possible varieties were sown in single observation plots with a dressing of 75 lb. per acre of double superphosphate. Lampton and R.L.1734 proved superior to Cedar and Ajax in vigour of growth, weed suppression, and freedom from disease, facts reflected in the grain yields of 29 lb. and 24 lb. respectively from 1/40th-acre plots against 12½ and 5 lb. of the remainder.

Trials will be continued and extended in the coming season.

Soya Beans

The aim of the soya bean work has been the testing both of local and introduced varieties chiefly for suitability to European mechanized farming methods. This necessitates even ripening, non-shattering, and the production of pods high up on the plant to enable the crop to be combine harvested.

None of the varieties tested has been found successful and, in the absence of any hybridization which cannot be carried out at the moment, the work has now been discontinued. It is possible that some of the varieties may be useful as hay or fodder crops and this aspect is being followed up.

Sunflowers

The three semi-dwarf varieties Mars, Pole Star, and Jupiter, have now been released to farmers from departmental control. These varieties are, however, not entirely successful since, although they are suitable for combine harvesting in the lower and hotter areas, they grow too tall in the cooler, higher-rainfall areas over 7,000 ft.

Work continued with mass and single plant selections in the fully dwarf varieties Klein, Southern Cross, Mennonite, and Sunrise. The last named, planted rather late in the season at Ol Joro Orok, grew to an average height of 18 in. to 2 ft. only.

Maize

The maize-breeding programme is following the aims outlined in the 1950 Report. In-breeding of the various lines continued, and a new series of in-breds was started using maizes collected from the African areas as well as imported varieties and hybrids. Trials of single and double crosses made in 1950 were carried out, and also top crosses of new selected in-breds to test general combining ability. Further tests with imported hybrids showed, as expected from past experience, that ready-made hybrids produced elsewhere were not successful in Kenya and emphasized that hybrids suited to local conditions must be produced on the spot.

The following is a summary of the main work carried out during the season. The programme allows for the free interchange of material between the three centres at which the work is carried out:—

Njoro.—The object is to produce hybrids suited to the higher and cooler maize-growing areas of the Colony.

Six hundred and fifty in-bred lines were under observation, consisting of material carried on from the 1950 programme together with some new selections. The original 21 in-bred lines were split up into a number of sub-lines with the object of detecting and testing possible differences between them. Of the remaining in-breds, 272 S1's from Njoro and Kitale material were reduced in the field, and after laboratory examination of the cobs and grain, to 94 to be carried on for further study; 126 S2's were similarly reduced to 59, and 67 S3's to 20. In-breeding of importations of in-breds and single and double crosses from the U.S.A., Southern Rhodesia and South Africa continued; and 58 lines surviving from the 1950 programme were further reduced to 19 S2 and S3 selections. In addition, in-breeding was started amongst the collection of local Kenya varieties, chiefly from the African areas, mentioned in the 1950 Report; 73 S1's out of a total of 84 original lines were carried on for further study. The Australian hybrids Q23, Regal N.E.H.18, D.S.28, D.S.30, Standfast G.H.96A, Victory G.H.134, and Ensign G.H.112.A, all of which grew poorly and were badly attacked by leaf blight, *Helminthosporium turcicum,* were in-bred in an attempt to establish pure early-maturing lines.

One hundred and ninety-three crosses, for doubling in 1952, were made during the season. Three hundred and sixty double crosses were made from the 1950 single crosses of which 250 gave sufficient seed for trial. These double crosses will be tested in suitably designed yield trials in 1952. Fifty-five top crosses of in-breds to the parent variety will be on trial in 1952 to test the general combining ability of new in-breds which have passed field and cob examination. Approximately 4,000 selfings were carried out at Njoro during the season.

Trials of the 74 single and 51 double crosses made in 1950 were carried out, from which none was found to yield significantly higher than Plant Breeding Station mass selected seed. The trial of top crosses of in-bred to parent made in 1950 showed, again, none to yield significantly higher than the parent. The eight highest-yielding combinations made in 1949 in the first stage of Dr. S. C. Harland's intra-genotypic method of maize improvement were crossed together in isolated plots, and a second cycle started by the selection of a further 200 single plants for crossing together in pairs in 1952.

Kitale.—The object is to develop lines suited to the hotter and heavier rainfall areas in which resistance to White Blight, *Helminthosporium turcicum,* is essential.

The programme follows much the same lines as at Njoro with the further selfing and selection of the established in-breds, S.1's, S.2's and S.3's from the new programme, and introductions from the U.S.A., South Africa, and Southern Rhodesia.

Top crosses of new S.1's to the parent variety were made to test general combining ability.

Rongai.—The programme at Rongai has as its object the development of lines, both white and yellow, for the drier areas of the Colony where earliness and drought resistance are required. Selection has been towards a flinty type of grain rather than the more starchy type of the higher rainfall areas.

Lines selected from the importations and local maizes advanced from S.2 to S.3, and the new selections made in 1949 from local yellow flinty maize advanced to S.2.

Sorghum

As more fully explained in the 1950 Report, the sorghum programme aims at the improvement of local varieties for African use and the production of dwarf types, suitable for combining, for use in European farming areas. No hybridization work has so far been carried out with the crop and the programme has been confined to the building up of a collection of local varieties and the testing of imported dwarfs, chiefly from America. This work has continued during the present season.

Summary of Season's Work

Njoro, 7,100 *ft.*—Njoro has too cold a climate for the satisfactory growth of sorghum, but introductions are first grown there as adequate supervision can be given and the seed supply increased for larger scale trials in other areas.

New Importations

The following introductions of both grain and fodder types were on trial for the first time. A fodder sorghum, which would yield a satisfactory bulk of material for ensilage or green feed during the short rains in the drier areas east of the Rift, would be a valuable addition to the possible crops in these areas.

From Dr. R. E. Karper, Lubbock, Texas, U.S.A.—The grain types: Hi-Hegari 5819-9-9-11, Redbine 56-5507-45-100-3, Redbine 60-5507-3-1-4-4-2-9, Redbine 66-5507-31-3-4-11-3-2, Combine Kafir 60-5765-22-1-3, Caprock 7000, Plainsman 7005, Martin 5330, Early Hegari 25248, Combine Kafir 5875-6-7 and 5878-48-1-5, and Red Combine 5507-31-3-4-2. The forage types: Honey (Sorgo) 21001, Honey x Leoti 5841-9-5 and 5841-10-1, Sumac 108 and 6550, Early Sumac 8720, Gooseneck 28212, Sweet Sudan Grass 372, Colliers 9628, Planters 1768, Tall Kafir x Sumac 7168, Tall Sweet Juicy 6716.

From Mr. J. B. Sieglinger, Stillwater, Oklahoma, U.S.A.—The forage and syrup types, Atlas C.I.899, Forage x No. 7, African Millet, White African, Sugar Drip, Colman 7, Sumac No. 1712, Honey Leoti, and F.C. No. 6610.

All these varieties were badly affected by the excessive rainfall of the season and were severely attacked by stalk borer.

Scott Agricultural Laboratories, 5,700 *ft.*—A number of the more promising varieties from the 1950 trials were again under test. However, excessive rainfall and stalk borer attack caused poor growth and failure to set seed.

Machakos, 5,000 *ft.*—Observation plots of 14 dwarf varieties from the U.S.A., South Africa, Bechuanaland, and the Anglo-Egyptian Sudan, were laid down at Machakos over the 1950/51 short rains season. The most promising appeared to be Early Kalo and Westland from the U.S.A., and Taungs White and Roma White from Bechuanaland. A yield trial at Machakos during the 1951 long rains season of six of the most promising importations and four local varieties, failed due to excessive rainfall. The varieties failed to ripen, remained green and produced a continuous crop of tillers. Observation plots at Poi, Kibwezi and Darajani in the lower country proved more successful, the most promising varieties being Caprock and Black Kafir.

Multiplication of varieties, which had proved promising in preliminary tests, was started, and the following varieties were given out to European farmers in the Machakos area for bulking over the 1951 long rains: Nine Caprock selections, Martin Combine, Black Kafir 5765-12-3, Trunane, Early Hegari, Radar, and Feterita Managil. Again owing to excessive rain and losses from cattle and birds, results were disappointing but a small quantity of seed was reaped from a number of the plots.

The collection of local sorghums, started last season, was increased and sown in the 1951/52 short rains, 29 local varieties and 65 introductions from the U.S.A. and South Africa being under study in observation plots. Some of the varieties may have use as forage types, and this aspect of the work is being kept in mind.

Miscellaneous Crops

The Dwarf Castor beans from Texas, and the Oil Poppies and Rapes from Professor G. Blackman, Oxford, were in observation and multiplication plots. Thirty Safflower selections, chiefly from Nebraska, U.S.A., received from Kongwa, were under trial for the first time. Growth was poor due to excessive rain and harvesting difficult. One variety proved to be completely spineless.

A Linseed yield trial with three varieties was laid down at Ol Joro Orok. A simple randomized block design was used with four replications. The plots were unfertilized. Results were:—

Variety	Rate Sown (lb. per acre)	Yield (Bags of 200 lb. net per acre)
Persian Gulf	68	5·46
Redwing	87	2·76
Canadian Royal	80	2·29
Significant Differences—		
P.05=		0·87
P.01=		1·32

Persian Gulf has significantly out-yielded ($P<.01$) the remainder. There is no difference in yield between Redwing and Canadian Royal.

Experimental Work

Wheat Rate of Seeding Trials

The extended programme, commenced last season in conjunction with Agricultural Officers, was continued. Owing to the wet year and difficult harvesting conditions, with much wheat lodged, yields are all lower than in 1950. Equally, and probably for this reason, all yields tend to be similar irrespective of seeding rates and in most of the trials no significant differences between rates can be demonstrated. The two exceptions, where significance between seeding rates can be demonstrated, are at Kitale, where the trial was harvested before the really heavy and continuous rains started, and Molo, where the crops matured after the rains had ceased.

The trials, which follow normal field practice, are laid down in randomized blocks with four replications (Ol Joro Orok has two replications only). Plot size was 1/5th acre each.

This season's results are:—

Njoro (7,100 ft.)				Rongai (6,000 ft.)				Molo (9,300 ft.)				Eldoret (7,000 ft.)		Ainabkoi (8,000 ft.)		Moiben (6,000 ft.)		Ol Joro Orok (7,800 ft.)		Kitale (6,000 ft.)	
360.H		294.M		360.H		294.M		318.AJ		Equator		294.M		1066		294.M		D.C. x Ceres R.64		294.M	
S.R.	Yield	S.R.	Yield	S.R.	Yield	S.R.	Yield	S.R.	Yield	S.R.	Yield	S.R.	Yield	S.R.	Yield	S.R.	Yield	S.R.	Yield	S.R.	Yield
55	5·3	106	5·6	70	6·8	84	6·1	151	6·5	84	4·5	88	6·5	51	7·5	135	5·5	115	4·7	120	6·5
108	5·3	60	5·4	55	6·6	71	5·8	123	5·0	119	4·3	151	6·4	71	7·4	70	5·4	127	4·0	105	6·3
130	5·1	71	5·3	28	6·4	60	5·7	94	5·0	148	4·2	101	6·3	60	7·3	92	5·3	69	4·0	90	6·3
28	5·0	83	5·3	108	6·4	124	5·6	70	5·0	104	4·1	137	6·1	111	7·0	144	5·2	154	4·0	75	5·7
76	4·9	27	5·1	130	6·2	106	5·6	49	4·8	63	3·5	74	6·1	130	7·0	86	5·1	31	3·9	45	5·3
70	4·7	36	5·1	38	6·2	36	5·2	136	4·8	44	3·3	45	6·0	34	7·0	45	4·8	53	3·8	30	4·7
38	4·5	124	4·9	76	6·2	27	5·1	25	3·4	23	2·6	30	5·1	90	6·9	35	4·7	92	3·7	—	—
P.05		Not Sig.		Not Sig.				1·6		0·7		Not Sig.		Not Sig.		Not Sig.		Not Sig.		0·8	
P.01		—		—				2·2		1·0		—		—		—		—		1·1	

S.R. = Seeding rate used.

Yield given in bags of 200 lb. net per acre.

Fertilizers used: Njoro—None.
Rongai—Superphosphate at 80 lb. per acre.
Molo—Guano 100 lb. per acre.
Eldoret—40 lb. double superphosphate and 90 lb. Guano per acre.
Moiben—None.
Ainabkoi—Double supers 60 lb. per acre.
Ol Joro Orok—Double supers 50 lb. per acre.
Kitale—180 lb. per acre of a 1 to 4 mixture of double supers and guano.

At Kitale there is an increase in yield from the 30 lb. to 45 lb. rate of 0.6 bags of grain per acre, and a further increase of 0.4 bags from this rate to the 75 lb. per acre rate—the total of one bag per acre increase from 30 lb. to 75 lb. per acre being significant at the 5 per cent point. From this rate there are further progressive non-significant increases in yield with additional seeding rates up to the highest rate used, 120 lb. per acre. This highest rate reaches significance (P = .05) over the 75 lb. per acre rate. All rates from 75 lb. upwards are better than 30 lb. per acre and from 90 lb. per acre upwards are better than 45 lb. per acre.

It is interesting to compare this result with the 1949 trial, using 261.R instead of 294.M as at present, in which a seeding rate of 70 lb. gave a significantly higher yield than all other rates. Above this rate there was a significant drop in yield to the 90 lb. per acre rate after which yields remained constant up to the highest rate used, 150 lb. per acre.

At Molo, with 318.AJ, the highest yield has been given by the highest seeding rate used, 150 lb. per acre, which just fails to reach significance at P = .05. This result may be regarded with some suspicion when it is seen that the difference between the next two lower rates, 136 lb. per acre giving 4.8 bags and 123 lb. per acre giving 5.0 bags, is only 0.2 bags and there would appear to be no reason for this sudden jump in yield with the higher seeding rate of 150 lb. per acre. Neglecting this value, there is an immediate increase of 1.6 bags per acre in yield from a seeding rate of 25 lb. per acre to 70 lb. per acre significant at P = .05. From 25 lb. to 49 lb. the increase in yield amounts to 1.4 bags per acre which fails to reach significance, and it is obvious that the experimental errors in the trial are high and mask all but the largest differences. There are no differences in yield between rates of 70 lb. to 150 lb. per acre.

With Equator all rates from 84 lb. to 148 lb. are equal in yield, and are better than the remainder at either the 5 per cent or 1 per cent points. The 63 lb. and 44 lb. rates give significantly higher yields (P = .05) than the 25 lb. rate.

The higher average yield of 318.AJ, 4.9 bags per acre, compared with Equator, 3.8 bags per acre, is worthy of note and bears out earlier remarks in this Report concerning the gradual replacement of Equator by newer higher-yielding hybrids.

Barley Fertilizer Trials

A fertilizer trial with barley was laid down at the three centres, Njoro, Molo and Ol Joro Orok, with the object of testing the effect of nitrogen, phosphorus and potash on both yield and malting quality.

Layout.—Incomplete randomized blocks of nine plots per block with two replications in 54 plots.

Plot Size.—12 ft. x 12 ft. Eighteen rows 8 in. apart, of which the inside 16 were harvested having one discard row at each side.

Planting.—The seed and fertilizer, previously weighed, were sown by hand in drills. The fertilizer was sown first, mixed with the soil, and the seed sown on top.

TREATMENTS

Nil	No fertilizer.
N1	Sulphate of Ammonia 25 lb. per acre.
N2	Sulphate of Ammonia 50 lb. per acre.
P1	Double Superphosphate 75 lb. per acre.
P2	Double Superphosphate 150 lb. per acre.
K1	Muriate of Potash 25 lb. per acre.
K2	Muriate of Potash 50 lb. per acre.

Barley Variety.—Research.

Harvesting.—The grain and straw were weighed, the grain beaten out in sacks, winnowed by hand, and weighed. In this Report grain weights only are considered.

OBSERVATIONS

At all three centres the plots receiving no phosphate could easily be picked out on account of their poorer growth. This held true quite irrespective of the application of either or both of the other fertilizers. Neither nitrogen nor potash had any visual effect on the growth of the barley.

Lack of phosphate also affected the establishment of the crop, those plots lacking this fertilizer being thinner in growth and containing fewer plants. Weed growth was also much greater in these non-phosphate plots; a score in the Njoro trial for weed growth accurately picked out these plots on account of the heavier growth of weeds.

Samples of grain from all three trials were sent to the East African Breweries for determination of grading percentage and coefficient of mealiness.

RESULTS

1. *Yields*

The Analysis of Variance table is appended from which it is seen that the application of superphosphate at all centres, sulphate of ammonia at Molo, the phosphate x potash interaction at Njoro, and the triple NPK interaction at all centres, have all produced significant results.

TABLE I—ANALYSIS OF VARIANCE

Variation due to	d.f.	Njoro		Molo		Ol Joro Orok	
		m.s.	"F"	m.s.	"F"	m.s.	"F"
Blocks	5	1·3368		0·9516		0·7533	
P	2	62·1671	154·72†	12·1031	27·35†	45·6693	80·53†
K	2	0·4967		0·0806		0·8130	
N	2	0·3430		1·5891	3·59*	0·0258	
PK	4	1·3142	3·27*	0·5904		0·5052	
PN	4	0·9111		0·5419		0·5627	
KN	4	0·3219		0·3824		0·5222	
NPK (unconfounded) ..	4	1·4371	3·58*	0·5545		1·5536	
NPK (partially confounded)..	4	1·5007	3·73*	3·3060	7·47†	2·8891	5·09†
Error	22	0·4018		0·4425		0·5671	
TOTAL ..	53						

*Significant at 5 per cent. †Significant at 1 per cent.

Yields given by the main treatments are:—

TABLE II—YIELDS OF MAIN TREATMENTS (BAGS OF 180 LB. NET PER ACRE)

	Njoro	Molo	Ol Joro Orok	Mean
P_0	4·07	10·39	3·73	6·06
P_1	9·91	12·76	8·58	10·41
P_2	10·36	13·29	9·25	10·97
K_0	8·32	12·13	7·62	9·36
K_1	7·75	12·03	6·82	8·87
K_2	8·26	12·28	7·13	9·22
N_0	7·98	11·53	7·22	8·91
N_1	8·42	12·62	7·11	9·38
N_2	7·94	12·29	7·24	9·16
Mean ..	8·11	12·15	7·19	9·15
Sig. Diffs.—				
P.05=	0·83	0·87	0·98	
P.01=	1·13	1·18	1·34	

Interaction PK Njoro.—It is seen that at Njoro the effect of superphosphate is less in the presence of muriate of potash than in its absence. This negative interaction is significant ($P<.05$) at the first level of muriate of potash but fails to reach significance at the second level.

TABLE III

INTERACTION PK NJORO (BAGS PER ACRE)

	K_0	K_1	K_2	Mean
P_0	3·88	3·99	4·32	4·07
P_1	9·53	10·27	9·94	9·91
P_2	11·56	9·00	10·53	10·36
Mean ..	8·32	7·75	8·26	8·11

Sig. Diffs. Means 1 per cent=1·13; 5 per cent=0·83
Single treatments 1 per cent=1·96; 5 per cent=1·44

MEAN RESPONSE TO SUPERPHOSPHATE (112½ LB. PER ACRE)

Muriate of potash	Bags per acre	Difference
(i) Absent	+6·66	
(ii) 25 lb. acre	+5·65	—1·01*
(iii) 50 lb. acre	+5·91	—0·75

(*Significant at P=·05)

Conclusions

(1) Application of double superphosphate at 75 lb. per acre has significantly ($P<.01$) increased yields at all three centres. A second application of a similar amount led to further small non-significant increases at all three centres.

(2) Application of sulphate of ammonia at 25 lb. per acre has produced a significant increase ($P<.05$) of 1.09 bags per acre at Molo. At the other two centres no effect was produced with the single or double dose.

(3) Muriate of potash has produced no effect on yield at any centre.

(4) There is a significant negative interaction ($P<.05$) at Njoro between superphosphate and muriate of potash at the lower level of application. NPK interactions are significant at all centres; remaining interactions are non-significant.

2. *Grading Percentage*

The percentages of grain held on No. 1 and No. 2 sieves, of 2.8 mm. and 2.5 mm. width respectively, are given for the main treatments. Such grain is classified as of acceptable malting size, and the percentage figures serve as an indication of the plumpness of the samples.

TABLE IV—PERCENTAGE OF GRAIN RETAINED ON NOS. 1 AND 2 SIEVES

	Njoro	Molo	Of Joro Orok	Mean
P_0	84·9	92·2	32·0	69·7
P_1	91·2	94·9	47·3	77·8
P_2	90·4	93·5	48·8	77·6
K_0	88·4	92·7	42·2	74·4
K_1	89·3	93·9	42·9	75·4
K_2	88·8	94·0	43·1	75·3
N_0	88·4	94·1	42·6	75·0
N_1	89·4	93·8	43·3	75·5
N_2	88·6	92·6	42·2	74·5
Mean ..	88·8	93·5	42·7	75·0

Conclusions

(1) Application of double superphosphate at 75 lb. per acre has led to large increases in the grading percentage at Njoro and Ol Joro Orok. The increase is smaller at Molo. A second similar application of superphosphate has had no effect at Njoro or Molo and has led to a further slight increase at Ol Joro Orok.

(2) Neither sulphate of ammonia nor muriate of potash have had any appreciable effect on grading percentage.

(3) There appears some evidence of a negative interaction between superphosphate and sulphate of ammonia at all centres.

(4) Molo and Njoro have produced the plumpest samples of grain.

3. 1,000 *Corn Weight*

One thousand corn weights for the main treatments are given in Table V. A satisfactory figure in Kenya from a maltster's point of view is usually considered to be 40 grammes and over per 1,000 corns.

TABLE V—1,000 CORN WEIGHT IN GRAMMES

	Njoro	Molo	Ol Joro Orok	Mean
P_0	41·4	43·1	39·1	41·2
P_1	43·0	43·3	38·5	41·6
P_2	43·5	43·1	39·2	41·9
K_0	42·4	43·1	39·2	41·6
K_1	42·7	43·3	38·6	41·5
K_2	42·8	43·2	39·0	41·7
N_0	42·7	42·8	38·9	41·5
N_1	42·8	43·5	38·8	41·7
N_2	42·5	43·2	39·1	41·6
Mean ..	42·6	43·2	39·0	41·6

Conclusions

(1) Double superphosphate at 75 lb. per acre has led to an increase in 1,000 corn weight at Njoro. A further similar application has led to a small additional increase. No effect was obtained at either of the other two centres.

(2) Neither sulphate of ammonia nor muriate of potash has had any appreciable effect on 1,000 corn weight.

(3) There is a suggestion of a negative interaction between superphosphate and sulphate of ammonia at all three centres.

(4) Molo and Njoro have produced the heaviest samples of grain.

4. *Coefficient of Mealiness*

The coefficient of mealiness is calculated as the number of fully mealy corns multiplied by two, added to the number of half mealy corns, and expressed as a percentage. Fully steely corns are not included in this figure. A satisfactory figure in Kenya for malting is usually considered to be 50 per cent and over.

TABLE VI—COEFFICIENT OF MEALINESS

	Njoro	Molo	Ol Joro Orok	Mean
P_0	66·0	41·4	5·7	37·7
P_1	71·7	70·4	9·9	50·7
P_2	75·4	69·8	16·3	53·8
K_0	69·5	58·1	8·7	45·4
K_1	71·2	56·8	9·2	45·7
K_2	72·3	66·7	14·0	51·0
N_0	77·3	62·6	10·4	50·1
N_1	67·9	64·0	9·6	47·2
N_2	67·9	55·1	11·8	44·9
Mean ..	71·0	60·6	10·6	47·4

Conclusions

(1) Double superphosphate at 75 lb. per acre has greatly increased mealiness at all centres. A further similar application has led to additional increase at Njoro and Ol Joro Orok.

(2) Muriate of potash at 25 lb. per acre has given a slight increase in mealiness at Njoro and Ol Joro Orok. A further similar application has shown substantial additional increases at Molo and Ol Joro Orok.

(3) Sulphate of ammonia has led to a decrease of mealiness at both Njoro and Molo. Little effect is noticed at Ol Joro Orok.

(4) There is evidence of a large negative interaction between superphosphate and muriate of potash at Njoro and smaller positive interactions at Molo and Ol Joro Orok.

(5) Njoro and Molo have produced the mealiest samples of grain.

5. *Grain Analyses*

Samples of grain from the various treatments at all three centres were chemically analysed and results are appended:—

TABLE VII—PERCENTAGE OF P_2O_5, K_2O AND N IN GRAIN (ON DRY MATTER)

	Njoro	Molo	Ol Joro Orok	Mean
	P_2O_5 PER CENT IN GRAIN			
P_0	0·374	0·592	0·578	0·515
P_1	0·432	0·576	0·543	0·517
P_2	0·452	0·649	0·557	0·553
K_0	0·411	0·615	0·597	0·541
K_1	0·416	0·601	0·543	0·520
K_2	0·430	0·601	0·539	0·523
N_0	0·420	0·612	0·579	0·537
N_1	0·431	0·603	0·591	0·542
N_2	0·407	0·602	0·508	0·506
Mean ..	0·419	0·606	0·559	0·528
	K_2O PER CENT IN GRAIN			
P_0	0·383	0·402	0·564	0·450
P_1	0·382	0·429	0·411	0·407
P_2	0·416	0·389	0·378	0·394
K_0	0·390	0·428	0·529	0·449
K_1	0·406	0·403	0·401	0·403
K_2	0·386	0·388	0·423	0·399
N_0	0·401	0·396	0·523	0·440
N_1	0·386	0·400	0·485	0·424
N_2	0·395	0·424	0·346	0·388
Mean ..	0·394	0·407	0·451	0·417
	N PER CENT IN GRAIN			
P_0	2·13	1·72	1·93	1·93
P_1	1·98	1·59	1·90	1·82
P_2	1·99	1·79	1·96	1·91
K_0	2·08	1·73	1·90	1·90
K_1	1·98	1·71	1·94	1·88
K_2	2·04	1·65	1·95	1·88
N_0	2·06	1·64	1·92	1·87
N_1	2·07	1·69	1·88	1·88
N_2	1·97	1·77	1·99	1·91
Mean ..	2·03	1·70	1·93	1·89

Conclusions

(1) Application of superphosphate has led to increase in the phosphate content of the grain at Njoro. Little effect is shown at the other centres. Little effect is shown on either the potash or nitrogen content of the grain, but there is a slight increase in potash at Njoro and a decrease at Ol Joro Orok with increasing applications of superphosphate.

(2) Application of muriate of potash has tended to reduce the phosphate, potash and the nitrogen contents of the grain except at Njoro where a slight increase in phosphate content is shown.

(3) Application of sulphate of ammonia has had no appreciable effect on the phosphate, potash or nitrogen contents of the grain at any centre except Ol Joro Orok where potash content of the grain has been lowered.

(4) There seems no evidence of any correlation between phosphate, potash or nitrogen content of the grain and either grading percentage, 1,000 corn weight or coefficient of mealiness.

Maize Variety Trials

In connexion with the hybrid maize-breeding programme, a collection of Kenya maize varieties was made for study and possible in-breeding. Opportunity was taken to test the yielding powers of the various varieties at a number of centres in the Colony and trials of the 42 varieties under test were, accordingly, laid down in co-operation with Agricultural Officers. The layout used at all centres was a 7 x 6 rectangular lattice design with four replications.

Trials failed at a number of centres for various reasons and results are appended of the four successful trials:—

DETAILS OF MAIZES UNDER TRIAL

Code Letter	District	Altitude	Rainfall	Time to Maturity
		feet	*inches*	*weeks*
A	Nyeri ..	6,000	37	12
B	Gedi ..	Sea level	40	12
C	Kilifi ..	200	45	12
D	Kilifi ..	500	45	14
E	Kilifi ..	200	45	14
F	Kilifi ..	200	45	12
G	Kimilili ..	5,800	55	30
H	Vihiga ..	5,200	75	20
I	Bukura ..	4,850	68	28
J	Bukura ..	4,500	60	24
K	Embu ..	4,000	21	20
L	Embu ..	5,000	50	20
M	Embu ..	4,000	21	28
N	Kitale ..	6,600	45	24
O	Kitale ..	6,800	45	24
P	Kitale ..	6,800	45	32
Q	Kitale ..	6,200	45	24
R	Nandi ..	6,500	51	28
S	Nandi ..	6,600	50	32
T	Nandi ..	5,800	55	32
U	Nandi ..	6,200	50	28
V	Nandi ..	6,500	52	28
W	Nandi ..	6,200	50	28
X	Nandi ..	6,200	50	28
Y	Kisii ..	5,400	60	24
Z	Kisii ..	3,800	50	16
AA	Porror ..	8,500	24	32
AB	Maralal ..	6,500	21	32
AC	Maralal ..	6,500	21	28
AD	Molo ..	8,000	45	28
AE	Njoro ..	7,000	35	32
AF	Sotik ..	6,000	55	28
AG	Buret ..	6,000	65	28
AH	Buret ..	6,200	70	24
AI	Buret ..	6,300	70	24
AJ	Sotik ..	6,300	55	36
AK	Sotik ..	6,200	45	32
AL	Lumbwa ..	7,000	42	24
AM	Buret ..	6,300	65	24
AN	Sotik ..	5,800	50	24
AO	Kitui ..	3,900	25	24
AP	P.B.S. ..	7,100	35	32

YIELDS (BAGS OF 200 LB. NET PER ACRE)

Embu 4,000 ft.		Machakos 5,000 ft.		Rongai 6,000 ft.		Ol Joro Orok 7,800 ft.	
E	38·0	G	22·9	AP	25·7	AI	18·2
G	32·1	AP	21·9	AE	24·0	AJ	17·4
AM	31·7	AL	20·4	AH	22·9	AH	15·7
I	29·6	AJ	20·3	H	22·7	AF	13·6
J	29·0	K	19·9	U	22·3	AE	13·3
Y	28·9	AN	19·1	S	22·0	AM	13·3
AD	28·1	AM	19·0	AK	21·8	AG	13·1
N	27·9	U	18·3	G	21·4	AK	11·8
T	27·6	AK	18·2	AN	21·1	N	11·4
L	27·1	T	18·1	AG	21·0	X	10·2
AN	26·9	AF	17·8	AB	20·9	AP	9·9
Q	26·6	S	17·3	AA	20·6	S	9·3
M	26·4	L	17·3	AF	20·6	R	9·1
P	26·4	D	16·8	AJ	20·5	T	8·8
AE	26·4	AH	16·7	AC	20·2	AO	8·8
AI	26·4	I	16·1	D	19·9	AC	8·7
H	26·3	X	15·9	X	19·5	AD	8·5
V	25·7	C	14·8	Y	19·1	U	8·4
X	25·3	N	14·7	P	18·8	AA	8·4
AF	25·3	AO	14·6	V	18·8	P	7·6
D	25·2	AC	14·4	Z	18·7	H	7·5
AL	24·5	J	14·1	T	18·6	D	7·2
AK	24·2	W	14·0	Q	18·3	M	7·0
R	24·1	AG	13·9	AL	18·1	AL	6·9
AH	23·4	O	13·9	AM	17·8	AN	6·9
AP	23·0	H	13·9	M	17·7	L	6·9
A	22·6	E	13·8	W	17·4	AB	6·6
O	21·9	AE	13·7	R	17·4	O	6·2
AJ	21·9	A	13·6	J	17·2	Q	6·1
AO	20·3	AB	13·4	K	16·8	F	6·0
K	20·2	M	13·3	AI	16·7	Y	5·8
AA	20·2	Z	13·3	N	16·4	V	5·7
U	20·1	F	13·2	A	16·2	K	5·7
Z	19·9	Y	13·2	O	15·8	E	5·5
AC	19·5	AA	12·5	L	15·8	J	5·5
S	18·3	V	11·9	I	15·0	G	5·1
AB	18·0	AI	11·0	AD	14·4	B	4·9
W	15·8	R	10·9	E	12·2	Z	4·8
AG	15·6	Q	10·6	AO	9·1	W	4·7
C	12·7	P	9·8	B	6·0	I	4·6
F	11·3	B	9·6	C	4·6	A	2·6
B	10·8	AD	6·6	F	4·3	C	1·3
Sig. Diffs.—							
1 per cent	12·17		10·30		8·74		10·12
5 per cent	9·02		7·03		6·48		7·50

Conclusions

As would be expected in a collection of maizes coming from widely differing climatic areas, coast level to 8,500 ft., and tested at four centres having very dissimilar climates, no clear-cut trends emerge and there is no variety which has done well at all centres. The superiority of the Plant Breeding maize at Machakos and Rongai, and of the variety from Kimilili at Embu and Machakos, is worthy of note. It is also interesting to observe the good yields given by the Sotik-Buret group of varieties at Ol Joro Orok, a high-altitude medium rainfall area, and to a lesser extent at the low-altitude, low rainfall stations Rongai and Machakos. This is quite unexpected.

Publications

1. "Results of the 1950 Maize Seed Competition" in the *K.I.O. Fortnightly* No. 224 of 3rd March, 1952, and in the local Press.

2. "Wheat Breeding in Kenya", in *K.I.O. Fortnightly* No. 208 of 18th June, and in the local Press.

3. "A Note on the Release of Some New Cereal Varieties—III", in the *East African Agricultural Journal*, Vol. XVII, No. 2—October, 1951, in *K.I.O. Fortnightly* No. 201 of 12th March, and in the local Press.

4. "Recommended Varieties of Cereals for Growing in the Coming Season 1951–52" in the *K.I.O. Fortnightly* No. 202 of 27th March, and in the local Press.

Acknowledgments

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H. C. THORPE,
Senior Plant Breeder.

COFFEE RESEARCH STATION, JACARANDA, RUIRU

Meteorological Data and Notes on the Weather During the Year

RAIN RECORD AT COFFEE RESEARCH STATION 1951

	A	B	C	D	E
	Inches	Inches	Inches	Inches	Inches
January	0·02	0·24	0·22	Nil	1·17
February	0·51	0·18	0·11	Nil	0·24
March	4·61	4·33	6·56	7·85	5·47
April	16·32	13·25	16·34	22·87	12·57
May	4·73	8·36	5·55	2·95	3·76
June	5·63	7·82	5·29	1·21	4·32
July	1·11	1·61	1·36	0·87	5·75
August	1·71	0·96	1·31	0·34	5·75
September	0·65	0·07	0·32	0·55	2·62
October	3·86	3·96	2·48	5·70	5·83
November	6·36	5·59	7·81	14·53	4·46
December	8·54	8·62	10·80	10·08	6·85
Total Inches ..	54·05	54·99	58·15	66·95	58·79
Total Days ..	165	148	147	123	178

A=Coffee Research Station, Ruiru.
B=Scott Agricultural Laboratories, Nairobi.
C=Anmer Estate, Kiambu.
D=North Kitito Estate, Makuyu.
E=Kitale Experimental Station.

Before the long rains arrived in March, coffee plantations in many areas were seriously affected by drought. The excellent rains, however, brought on the best coffee crop for many years. The final crop is expected to exceed 16,000 tons, estimated to be worth £7,000,000.

The good rains have made available abnormally large quantities of mulching grass which, coinciding with an extension drive based on results of field trials to encourage the practice of mulching, resulted in a much greater acreage of coffee being mulched than at any previous time.

Evidence is accumulating to support the view that biological control of the common coffee mealy bug (*Planococcus kenyæ* Le Pelley) is likely to break down seriously in periods of drought. Two major breakdowns have now been recorded at what proved to be the terminal part of a period of drought years. The periods in question were October, 1945, to March, 1946, and October, 1950, to March, 1951. During 1951 the efficiency of biological control increased steadily until by the latter part of the year it might be said that control was virtually complete at a point below the economic damage level.

The year produced the first recorded outbreak of coffee berry disease in the East Rift area. While research on this whole problem is now being actively taken up again, it is safe to say that the unusually cold, wet weather experienced, particularly in Upper Kiambu, had a lot to do with the appearance of the disease.

Abnormally heavy falls of rain produced very serious soil damage on some estates and this led to a better appreciation of requirements from both the technical and extension angles. The value of mulching before the rains as a soil conservation measure (apart from any other benefits) was fully supported.

ANNUAL REPORT OF THE ENTOMOLOGICAL SECTION, 1951 COFFEE RESEARCH STATION

The Search for Further Natural Enemies of the Common Coffee Mealy Bug in Uganda

During 1951 the section was mainly concerned with work on biological control of the coffee mealy bug, *Planococcus kenyæ* (Le Pelley). From early March until the end of November Mr. McCrae was in Uganda collecting further species of internal parasites and predators for introduction into the East of Rift area of Kenya where *P. kenyæ* occurs.

The initial purpose of the search in Uganda was to obtain living material of two internal parasites known to attack *P. kenyæ* there, namely a species of *Tetracnemus* and a further species of *Anagyrus*. These parasites had been found by Mr. Melville in 1938 when he carried out the original search for parasites of *P. kenyæ*, but were not bred in Kenya at the time owing to pressure of work with other species then being introduced.

Only one of these parasites, the *Anagyrus*, was found in sufficient numbers to be bred at the Coffee Research Station; the *Tetracnemus* was found to be much more scarce than in 1938 and with the small number obtained, it was not found possible to breed it.

Many Coccinellid predators of *P. kenyæ* were found, however, and in view of the scarcity of the required parasites it was decided to investigate this aspect of the biological control of *P. kenyæ*. This involved a survey of the indigenous Coccinellid predators of *P. kenyæ* in Kenya so that it could be decided which of the Uganda predators would be worth importing. It was found that many of the Uganda Coccinellids were already present in Kenya and from the remaining species it was decided to attempt to breed the following species in the insectary at Ruiru. As a result of observations in Uganda all of them appeared to be species of considerable promise:—

Hyperaspis senegalensis Muls.
Hyperaspis quadrilla Muls.
Hyperaspis sp. nr. *delicatula* Muls.
Scymnus sp. nr. *alienus*.

Uganda specimens of *Hyperaspis* sp. nr. *delicatula* differed in certain larval characteristics from those found in Kenya, but it is possible that this is due to climatic conditions and this species may prove to be common in both territories. A third parasite, *Allotropa* sp. (*Scelionidæ*) was obtained in good numbers at Kawanda in Uganda and attempts were made to breed it in Kenya, but they were not successful. The search for these parasites and predators was carried out in the Toro District and in the Kampala area of Uganda. Mr. Melville visited Kampala in November in order to obtain further knowledge of the *P. kenyæ* complex existing there and to decide on future policy for further introductions of beneficial insects to improve the control already achieved of the coffee mealy bug in Kenya.

Grateful acknowledgment is made of the help given by the Department of Agriculture of Uganda, particularly by the Senior Entomologist—Mr. A. P. G. Michelmore and Mr. A. E. B. Williams, Agricultural Officer, Toro, in the course of this search.

The Mealy Bug Situation in Kenya in 1951

In the East Rift area of Kenya numerous and often serious local outbreaks of *P. kenyæ* occurred during January, February and March. These outbreaks

were eventually brought under control by parasites and predators, but occurred again during the colder months of June and July. From September until the end of the year, biological control became increasingly efficient and the mealy bug became hard to find on many estates. It is becoming ever more apparent that failure of biological control is associated with drought conditions. In periods of good rainfall biological control is remarkably efficient.

One hundred and thirty-two liberations of *Anagyrus* sp. nr. *kivuensis* were made during the year involving a total of 48,872 individuals of both sexes. This insect continued to be the dominant parasite of *P. kenyæ* in Kenya. At times it was closely approached in efficiency by *A. beneficans* Comp., and *Pauridia peregrina* Timb. *Leptomastix bifasciatus* Comp., the dominant parasite of the indigenous complex in Toro, Uganda, was noted occasionally from the Kiambu district but still plays a minor role in Kenya.

Predatory insects were of importance in controlling outbreaks which had occurred due to failure of internal parasites provided that efficient measures were taken to prevent the attendant ant, *Pheidole punctulata* Mayr. from gaining access to the mealy bug. The most important predators noted during the year were *Hyperaspis* sp. nr. *delicatula, H.* sp. nr. *senegalensis, Exochomus nigromaculatus* Goeze, *Chilocorus angolensis* Crotch and several *Scymnus* spp. *Xenocrepis secundus* Cwfd. occurred as a parasite of the larvæ of *H.* sp. nr. *senegalensis,* its effect at times being serious. *Chrysopa* sp. was also noted as an efficient predator, and seemed to be especially prevalent in mealy bug outbreaks resulting from the persistent action of D.D.T. applications to control other coffee pests.

Experimental work on control of *P. kenyæ* was mainly directed towards finding efficient substitutes for banding grease to prevent the access of ants to the mealy bug. Of many substances tried the most efficient were:—

(1) Dieldrin, either as a wettable powder or as an emulsion.

(2) Dedetane Paste—a proprietary D.D.T. preparation.

As neither banding grease nor dieldrin was commercially available and as stocks of Dedetane paste soon became exhausted, the final emergency recommendation to growers was to apply a 15 per cent D.D.T. emulsion as a 10-in. band at the base of the tree at a rate of two pints of D.D.T. emulsion to four gallons of water, the diluted emulsion being applied with a brush or piece of sacking. Treatment had to be repeated frequently to obtain satisfactory control. In general, advice to planters as regards mealy bug control was:—

(1) Control of *P. punctulata.*

(2) Removal of suckers, i.e. young vertical growth from the main stem of the tree.

(3) Control of green scale, *Coccus africanum* Newst.

The last two measures were advised in order to minimize the effect of hyperparasites which appears to be more severe during periods of vigorous sucker growth and where mealy bug and green scale are present together. In previous annual reports it has been shown that the most common mealy bug hyperparasite (*Pachyneuron* sp.) also attacks the primary parasites of green scale.

The following insect pests were noted most frequently during 1951:—

Green Scale

(*Coccus africanum* Newst.)

This insect was reported to be present in economic proportions in many areas but its effects were not always serious. As stated above, it was deemed desirable to control it where it was in association with *P. kenyæ.* Several instances of serious damage being caused by green scale following the use of D.D.T. were reported. Advice to planters was to control it by means of oil emulsion sprays or by banding the trees against *Pheidole punctulata* in order to enhance the effect of predators.

Antestia spp.

Throughout the year *Antestia lineaticollis* Stal. and *A. faceta* Germ. kept to low proportions in areas east of the Rift Valley. No control measures were necessary at the Coffee Research Station.

An examination of defective parchment coffee was started in December in order to clarify the nature of the damage attributable to *Antestia* spp. in Kenya and to assess the efficacy of a pre-washing channel in coffee factory practice in separating such damaged beans from the mass.

Recommendation of B.H.C. products as sprays against *Antestia* was withdrawn because these have been proved to cause an undesirable taint known as "bricky flavour" in coffee. D.D.T. wettable powders at 0.1 per cent D.D.T. gave good control of *Antestia* but the department has continued to advise the use of pyrethrum powder dusting in conjunction with routine testing as being less likely to interfere with beneficial insects, except where *Antestia* populations were very high. D.D.T. should only be used in coffee blocks where the *Antestia* population has been allowed to become excessive through neglect of control measures, or for some other reason.

The Lace-wing Coffee Bug

(*Habrochila placida* Horv.)

Mr. Melville visited the Turbo district twice during the year to investigate outbreaks of the lace-wing coffee bug (*Habrochila placida* Horv.). Outbreaks had occurred on two plantations, causing serious damage in 1950 and 1951. The only plantations seriously affected were those on which D.D.T. spraying had been carried out previously, and there was a strong indication therefore that the outbreaks had been caused by the effect of this insecticide on natural enemies. Hargreaves (writing on lace-wing coffee bug in "Agriculture in Uganda" by Tothill) gives an account of a Capsid predator of the lace-wing bug which he considered to be capable of exerting a strong control on this pest. This predator (*Stethoconus* sp.) was found in good numbers on both affected estates in Turbo and was observed to be feeding on lace-wing bugs in the field. With the co-operation of the planters concerned, observations have been made to discover whether the Capsid is capable of controlling the pest in the absence of D.D.T. and evidence to date seems to leave little doubt that the seriously high populations of lace-wing bug have been caused by the effect of D.D.T. on the predator.

Uganda experience indicates that even in the presence of the predator some severe damage may sometimes be caused to a few trees but no devastating outbreaks as experienced at Turbo have ever been reported. It may, however, be necessary to use an insecticide on odd localized infestations, and nicotine sulphate/soap spraying has been tentatively advised to avoid the serious repercussions resulting from the use of persistent insecticides. Another interesting feature on one of the estates in question has been the considerable amount of damage which has been caused by green scale in the same period. This suggests a similar interference with natural control.

Coffee Thrips

(*Diarthrothrips coffeæ* Williams)

Thrips reached pest proportions in the east of the Rift districts of Ruiru and Thika in March and April. Control of the outbreaks on unwilted foliage was achieved by use of the Paris Green/Molasses spray, previously reported. On wilted foliage, D.D.T. wettable powder at a strength of 0.1 per cent gave good control.

Advice to planters was to spray known thrips foci whenever the population showed any tendency to rise. Warnings to planters were issued in the Press and on the wireless when thrips outbreaks were expected.

White Stem Borer

(*Anthores leuconotus* Pasc.)

A compulsory campaign against this pest was conducted by the Department of Agriculture from 1st January to 31st March. The districts affected were Makuyu, Maragua, Mitubiri and Donyo Sabuk.

The control measures consisted of excavating a conical depression round the base of each and every tree so that the subsequent appearance of frass would indicate the presence of borer larvæ in the tree. Larvæ in the tunnels were fumigated with a mixture of one part of ethylene dichloride (75 per cent)/carbon tetrachloride (25 per cent) ("Killoptera") and one part aviation spirit introduced on a piece of cotton wool to the open end of the tunnel, the entrance hole being subsequently plugged with wet earth. These annual compulsory campaigns are keeping the borer under effective control and the benefit accruing to coffee growers in these districts must be considerable.

Berry Blister

In October a blistering of coffee berries was reported from Songhor. Examination of a sample showed the damage to be caused by a gall midge. Although no adult insects were reared from the material, it is thought likely that the damage is caused by the same insect as is mentioned by the Senior Entomologist (Uganda) on page 10 of his report on "Coffee Entomology and Pathology, 1946–1948" (published by the Government Printer, Entebbe, Uganda. 1949).

General

Supply of insecticides was in general unsatisfactory during the year. This is due in large measure to the unwillingness of importers to order or carry sufficient stocks to meet emergencies.

The reason for this is thought to be that importers feel that the introduction of a new insecticide or methods might leave them holding stocks of unwanted materials.

While there is no doubt that D.D.T. has given the coffee grower a formidable weapon against *Antestia* and thrips, the department has continued to advocate caution in the use of this insecticide.

Numerous cases are now on record to show that serious interference with biological control can occur following the use of D.D.T. In some circumstances D. .t. must be used to achieve control, but whenever possible growers are advised to limit the areas so treated and to stagger spray applications in time so that interference with natural enemies is reduced to a minimum.

Recommendation of B.H.C. products on coffee was withdrawn because research has shown that such can produce a taint known as "bricky flavour" (*see* Annual Report of Plant Pathologist/Physiologist). Investigations with improved B.H.C. formulations are in hand.

A considerable number of coffee planters have availed themselves of facilities offered by the section for training Africans as pest "spotters".

Extension work, comprising visits to estates, preparation of articles for publication and demonstrations of control measures have occupied a considerable amount of the time of section staff.

A. R. MELVILLE,
Senior Entomologist (Coffee).

D. J. McCRAE,
Entomologist

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (COFFEE SERVICES) FOR 1951

Copper Spray Trials

The layout and design of these trials has been fully described in previous reports; Trial I in the 1947 Annual Report and Trial II in the 1948 Annual Report. Counts of leaf fall in both trials ceased during May; at this time recording of growth and leaf shedding commenced in Trial III. Since 1947 a considerable volume of leaf fall data has been collected from both trials. These records will be included in a separate progress report of the field and laboratory investigations of the tonic spray problem undertaken by the Coffee Team since 1947. In contrast to the previous year the level of cropping was high in both trials, this and the heavy leaf fall, which occurred after the long rains, subjected the trees to some strain which was reflected in the excessive number of branches suffering die-back at the end of the year. The effects were alleviated to some extent by ample rainfall, providing an uninterrupted supply of available soil moisture, from the time of flowering until the crop had ripened.

Trial I.—Copper sprays were applied on 22nd May at the peak of the long rains growth period.

Throughout the picking season 10 per cent samples of the cherry yield of every plot were extracted for conversion to clean coffee. Samples were bulked to form an independent estimate of the cherry/clean coffee ratio for each plot.

Yields of the 1951 crop and the five-year totals are shown below:—

YIELDS IN CWT. PER ACRE

	Clean Coffee 1951	Per cent of Control	Cherry Total 5 years	Per cent of Control
1. TYPE OF SPRAY—				
(Tc) Carbide Bordeaux	13·9	138	184·2	146
(Tb) Burgundy	14·9	147	193·7	153
(Tp) Perenox	14·1	139	190·3	151
Significant difference within types ..	1·34	13	19·7	16
Control—no spray	10·10	100	126·2	100
Significant difference—sprayed *v.* control	1·22	12	18·0	14
2. CONCENTRATION—				
(C_1) 1 per cent	14·1	139	185·9	100
(C_2) 2½ per cent	14·9	147	202·3	160
(C_3) 4 per cent	14·0	138	180·0	143
Significant difference within concentration	1·34	13	19·7	16
Control—no spray	10·1	100	126·2	100
Significant difference—sprayed *v.* control	1·22	12	18·0	14
3. RATE—				
(R_1) 2/3 pints per tree	14·1	139	183·8	146
(R_2) 4/3 pints per tree	14·5	143	195·0	154
(R_0) Control	10·1	100	126·2	100
Significant difference	1·09	11	16·1	13
Coefficient of Variation	8% of the mean		11% of the mean	

Significant differences in clean coffee yield among treatments were confined to the marked inferiority in yield from unsprayed trees. In spite of heavier crops sprayed trees suffered less die-back than the unsprayed controls.

In the five-year totals of cherry yields, the following differences are significant:—

(*a*) All types, concentrations and rates of application of sprays led to the production of very much heavier crops than the unsprayed controls. The improvement of yield, as shown in the table, amounted to 43 per cent to 60 per cent.

(*b*) The median concentration, 2½ per cent, was superior to the extremes, 1 per cent and 4 per cent, to the extent of 13 per cent and 17 per cent in total cherry produced.

(*c*) Comparison of pairs of factors gives the following significant differences:—

R_1C_2 and R_2C_2 greater than R_1C_3

T_0C_2 greater than T_0C_3

The superiority of the 2½ per cent concentrations is thus confirmed in part, although the regularity of the response is lacking. The scope of the trial has been limited throughout by the lack of fundamental knowledge available when it was laid down. The fungicidal role of tonic sprays was established two years later.

In 1951 the action of a number of types of hand pumps was examined and studies of the spray cloud, droplet size and underleaf cover produced allowed valid comparisons of their efficiency. Tests showed that the type of pump used for this trial, and for Trial II did not produce an effective underleaf cover. Hence it must be concluded that the action of the sprays tested in the trial was impaired.

The effect of the factors tested is also dependent upon a fourth and crucial factor, namely the time of application of the spray, which was not the subject of investigation in this trial.

The absence of regular differences between treatments is not due to high intra-treatment variability, but any of the undesirable features mentioned may be responsible.

Trials I and II were concluded at the end of the year and superseded by a third trial in which the time factor is incorporated and an effective underleaf cover is achieved.

Trial II.—Burgundy sprays at 2 per cent strength and 1½ pints per tree, were applied at three stages of the long rains growth period, viz.:—

Early spray on 18th April, middle spray on 21st May, late spray on 13th July. The three dates represent the beginning, the peak and the end of the growth period and cover the times at which copper sprays could be expected to exert a beneficial influence on the tree.

Estimates of clean coffee yield were obtained by the method described for Trial I.

Yields of the 1951 crop and the three-year totals are shown in the table below.

YIELDS IN CWT. PER ACRE

Time of Spray	Clean Coffee 1951	Per cent of Control	Cherry 3-year Total	Per cent of Control
(*a*) Early	12·36	105	99·0	131
(*b*) Middle	12·62	107	100·2	133
(*c*) Late	13·09	111	100·1	133
(*d*) Early and Middle	13·18	112	108·0	143
(*e*) Early and Late	11·96	101	102·7	136
(*f*) Middle and Late	13·64	116	112·3	149
(*g*) Control—no spray	11·79	100	75·5	100
Significant difference	1·85	15·5	9·9	13·1
Coefficient of variation	11 per cent		8 per cent	

Among the 1951 yields only one difference attained significance: plots receiving the middle and late spray produced more clean coffee than the unsprayed controls, an improvement which amounted to 16 per cent of the yield of control. The absence of a general response to the middle spray, which appears in Trial I, is inexplicable at the present stage of the investigation.

In the three-year total cherry yields the following real treatment differences appear:—

(*a*) Spraying induced an increase in yield of 31 per cent to 49 per cent.

(*b*) The double spray (F) applied at the peak and again at the end of the growth period induced an increase in yield of approximately 12 per cent over the single spray treatments (A, B, C). A poor underleaf cover may again account for the absence of greater difference between treatments.

Pruning Trial.—The comparative yields of the four systems of pruning, since regeneration in 1945, are given in the table below.

YIELDS IN CWT. OF CLEAN COFFEE PER ACRE

Year	Multiple stem	Single stem (uncapped)	Single (capped)	Single two stem	Significant difference
1946	2·31	1·59	0·58	2·09	0·4
1947	13·55	6·15	5·82	10·01	1·4
1948	2·05	0·98	1·43	0·72	0·7
1949	5·79	3·86	3·57	3·09	1·0
1950	1·25	2·99	1·60	1·50	1·5
1951	15·17	15·89	16·40	17·45	1·9
6 years total	40·12	31·46	29·40	34·86	3·5
Per cent of mean yield	118	93	87	103	10·3
Mean yield per annum	6·69	5·24	4·90	5·81	0·6

All treatments bore exceptionally heavy crops in 1951; the single-stem plots all bore more crop in a single year than their total crop over the previous five years. Only one treatment difference was significant, however; the single two-stem system produced over two hundredweights of clean coffee more than the multiple stem. At this time the latter was in the last year of full cropping in the cycle; regeneration to the second cycle commenced after the crop was harvested.

The six-year totals illustrate the superiority of the multiple-stem method of regeneration. The differences in crop production were: Multiple stem > double stem (by 15 per cent) > single stem (by 6 per cent and 10 per cent).

Summation of the yields into three two-year totals illustrates the changes in the relative yields of treatments during the six-year period, viz.:—

CLEAN COFFEE—CWT. PER ACRE

Years	Multiple	Single stem (uncapped)	Single stem (capped)	Single two-stem
1. 1946 and 1947	15·86	7·74	6·40	12·10
2. 1948 and 1949	7·84	4·84	5·00	3·81
3. 1950 and 1951	16·42	18·88	18·00	18·95

In the first period the higher yields of multiple stem and double stem are notable. In the second period, while the multiple stem maintained higher yields, the double-stem crops were lower than that of single stem. In the third period yields of all systems were of the same order with multiple stem yielding less than the others.

During 1952 and 1953 light crops are expected from the multiple stem, while the trees are changing to the second cropping cycle.

Fermentation Trials.—Investigations conducted in 1949, and reported in the 1950 annual report, were continued in a series of four trials during the 1951 season. The chief subject of study in these trials was the effect on the quality of coffee of washing during fermentation. The normal duration of fermentation at the Research Station is 65–70 hours; that is coffee pulped at 4 p.m. is finally washed and graded at 8 a.m. on the third morning after pulping; the coffee remains in tanks for two full days, therefore.

The treatments tested were—no washing, washing once a day (at 8 a.m. each morning—twice during fermentation); washing twice a day (morning and evening—four times during fermentation); washing three times a day (morning, midday and evening—six times during fermentation).

In each trial bulk coffee was fermented without water; on each occasion sub-samples were drawn from the bulk, as a full replication of the treatments in main tanks, for fermenting dry and under water in basins. From the four trials, six comparable replicates of the treatments on bulk coffee and six of each type of sub-sample were obtained. The total scores for liquoring quality are tabled on the following page:—

TREATMENTS

MAIN TANKS, BULK COFFEE: DRY FERMENTATION	Control No washing	Washed once a day	Washed twice a day	Washed thrice a day	Significant difference
	(W_0)	(W_1)	(W_2)	(W_3)	
Score for liquor ..	143	135	136	134·5	6·2
Per cent of control (W_0)	100	94·6	95·1	94·1	4·4
Total quality score ..	397	398	395·5	392·5	14
SUBSAMPLES BASINS					
Dry fermentation total quality score ..	389·5	391	389	387	12
Under water fermentation total quality score	384·5	382	380	381	11

From the above it follows that washing during fermentation has improved the liquoring quality by 5 to 6 per cent, although no improvement is apparent in the overall assessment of quality. Nor did washing have any apparent effect on the liquoring quality of sub-samples. The total score for the bulk coffee was 1,583, for underwater sub-samples the total was 1,527.5. The difference between the two was highly significant and in favour of the latter method. This result is in line with trends shown in previous trials in 1949.

The presence of onion taints was reported in five of the numerous samples; in each case the coffee had not been washed during fermentation.

Cultivation and Manurial Trials.—These trials, conducted jointly with Dr. Pereira and forming the basis of the investigation of soil moisture and fertility problems, were continued for the fifth year. The results have been studied and submitted for publication in the *Empire Journal of Experimental Agriculture.*

Variety Trials—Anmer Estate, Kiambu.—The layout of both trials reported here was described in full in the 1948 annual report. A summary of the results obtained to date is given below.

Variety Trial I.—The 1951 yields and the totals for the four years 1948–51 are tabled below:—

YIELDS AS CWT. OF CHERRY PER ACRE

SELECTION	1951 yields	Total yields of 4 years 1948–51	Per cent of Control
SL3	58·7	141·3	77
SL9	42·4	230·9	126
SL14	76·8	263·3	144
SL17	54·9	255·7	140
SL28	44·3	216·3	118
SL30	32·0	221·6	121
SL34	61·2	237·9	130
Kenya Selected	73·2	256·3	140
J2D	71·3	241·6	132
Control (French Mission) ..	47·8	182·7	100
Significant difference within varieties	36·7	54·1	30
Differences between varieties and control	29·0	42·8	23

From the table the following differences in yield are significant:—

1951 yields—
SL 14 greater than control,
SL 14 and Kenya Selected greater than SL 30

Four-year totals—
SL 9, SL 14, SL 17, SL 34, Kenya Selected and J2D greater than control and SL 3.
SL 28 and SL 30 greater than SL 3.

Although samples were taken for clean coffee estimation these were obviously unreliable and could not be used; yields are recorded as cherry, therefore.

Quality Factors.—Since 1947 ten complete sets of quality samples have been obtained for comparing the liquoring value of varieties. Analysis of the scores allotted for quality shows the superiority of SL 28 compared with SL 3, SL 14, SL 17, SL 30, Kenya Selected and Control. The mean classification for SL 28 was 2.3, which was superior to the others by 15 per cent to 24 per cent in the relative quality scores or a third to half a class better.

Variety Trial II.—By similar means the productivity of ten selections was compared with controls of SL 28. The yields for 1951 and the four-year totals are tabled below:—

YIELDS AS CWT. OF CHERRY PER ACRE

SELECTION	1951 yields	Total yields 4 years	Per cent of control
SL10*	94·0	171·1	124
SL33*	35/8	61·2	44
KIT37	82·2	123·5	90
KIT61	60·5	108·0	78
KIT85	54·3	69·5	50
KIT145	36·1	82·5	60
KIT251	47·9	78·6	57
M83	57·0	99·1	72
M65	72·5	113·8	83
M6*	68·4	99·6	72
Control SL28†	74·3	137·7	100

*mean of 4 trees.
†mean of 32 trees.
Yields of other selections are the means of 8 trees.

Among the significant differences between varieties in the 1951 yields the following are worth recording:—

SL 10 > SL 33, KIT 61, KIT 85, KIT 145, KIT 251, and M 83
Control and KIT 37 > KIT 145 and KIT 251.

The notable differences in the four-year totals are:—

SL 10 > all varieties except Control and KIT 37
Control and KIT 37 > SL 33, KIT 85, KIT 145, and KIT 251.

Quality Factors.—Since 1948 five complete sets of quality samples were obtained. Analysis of the quality scores shows one real difference between varieties, namely KIT 85 was superior to SL 10 in quality, the mean difference being approximately one class. The average classification of KIT 85 samples was three, that for SL 10 was approximately four.

P. A. JONES,
Agricultural Officer.

ANNUAL REPORT FOR 1951 OF THE PLANT PATHOLOGIST AND PHYSIOLOGIST, COFFEE SERVICES

Introduction

The main emphasis has continued to be on the effects of copper spraying on leaf fall and cropping. The small-scale trials at Solai have been followed by a full-scale yield trial to test times of spraying, rates, and concentrations. Small-scale trials of the effects of Phenyl Mercury Fixtan spray, of hormones, of position of treatment with copper sprays and of concentration effects have been carried out, and further investigations of the nature of "weak spots" made.

Coffee berry disease made its first appearance in the main East Rift coffee areas and investigations into it have been recommenced.

Other investigations included those into the cause of bricky flavour of coffee liquor, the effects of Maleic Hydrazide spraying, the types of spraying apparatus available on the local market, and growth recording.

Leaf Fall and Copper Sprays

1. Field Trial of Copper and Non-Copper Containing Fungicides

The trial which is aimed at present at finding out whether non-copper containing fungicides have the same effect on yield as copper containing sprays, has been continued for a final year. It is situated at the Scott Laboratories and is a combination of a 6 x 6 Latin Square and a 6-plot randomized block. Clean coffee figures are not to hand, as the crop has not yet been hulled. A full analysis of the results, including the 1950–51 crop, was given last year. The figures for leaf fall during 1951 also have not been analysed.

On 25th June the trees were scored for density of leaf and leaf colour. The Bordeaux and Burgundy treatments showed the highest leaf density and deepest green colour. The Control, "Watered-on Copper" and Lime Sulphur were intermediate for density and Tulisan was lowest. For colour, "Watered-on Copper", Lime Sulphur and Tulisan were intermediate with Control least deep. Thus "Watered-on Copper" has dropped from having as deep a colour as the copper spraying treatments during the last three years, to an intermediate position. Possibly the watering-on of copper sulphate does not have the same effect on colour as the injection which was employed in the first year and the effect of this is now gradually wearing off.

On 3rd September, scores were taken for "weak" spotting. Only leaves which had been formed during the previous long rains were used, so that comparable figures could be obtained without interference from different amounts of leaf fall due to the various treatments, since none of the long rains leaves was old enough to have been shed at this time.

Yellow spotting due to spray damage was shown by the copper sprayed trees, especially with the Burgundy treatment, but with care it was possible to distinguish this from weak spotting. Ten leaves were scored on each tree on a scale of 0–5.

The following results were obtained:—

	Score	Per cent of Control
		Per cent
Control	242	100
Copper Watered on	228	94·2
Tulisan	160	66·1
Lime Sulphur	124	51·2
Burgundy	104	42·9
Bordeaux	57	23·6

Thus all the fungicidal sprays appear to have reduced the amount of "weak" spotting considerably, the copper sprays being more efficient than the non-copper sprays.

2. The Effects of Copper Spraying at Different Times of the Year

The experiment at the Scott Laboratories is now nearly concluded, but analysis based on the effects on individual leaf life must wait until all leaves present at the time of the last spraying have fallen. This should have occurred before the onset of the 1952 long rains. The same applies to the similar records taken at Solai. It is noteworthy that at this locality, there was a distinct and severe leaf fall period in July–August, and thus the leaf fall pattern resembled that of the main East Rift area and was quite distinct from that observed last year, when there was only one leaf fall period extending from the end of September through into February and March.

3. Field Trial of Copper Spraying at Solai

In view of the 1950 results of the small-scale trial mentioned above, it was decided that a yield trial of copper spraying could now be embarked upon. Mr. Geoffrey Ireland very generously put an area of coffee at my disposal adjacent to that used in the previous trial.

The trial is of a factorial design and consists of two replications of a 4 x 2 x 2 layout. There are four times of spraying: nil, end of May, mid-July and end of September. The sprays were applied at two rates, 1 and 3 pints per tree and at two amounts of copper per tree 0.13 oz. and 0.065 oz. This is equivalent to 1 per cent and 2 per cent Perenox at 1 pint per tree and $\frac{1}{3}$ per cent and $\frac{2}{3}$ per cent at 3 pints per tree. The two replications were divided by confounding into four blocks of eight single-row, 20-tree plots, giving 32 plots in all. The trees are multiple-stem and mostly in a late stage of the cycle. The plots are arranged in a single series. Spraying was carried out on 22nd May, 17th July and 25th September. Three pickings were made only; on 26th to 28th November, 3rd to 5th January and 11th to 12th February; coffee ripening between these being allowed to dry out on the tree and being picked as buni. The final picking included stripping. The crop of each plot was weighed in the field and after thorough mixing, a sample of 1/10th this weight was taken back to the laboratories, where it was sun dried. When convenient, it was soaked in water for 24 to 48 hours or more until the fruit wall was soft and then pulped. In this way much of the fruit wall was removed so facilitating extraction of clean coffee at a later date. The pulped coffee was dried and hulled, its weight will be obtained and the amount of A grade determined. From these figures, the yield in clean coffee of the experimental plots may be calculated.

4. Branch Leaf-fall Trials at the Coffee Research Station

Three trials of the effects of various substances and treatments on leaf fall were carried out during the long rains.

A—Type of Spray

The treatments were:—

1. 2 per cent Perenox (as a standard).
2. Phenyl Mercury Fixtan (0.025 per cent).
3. ∝-naphthalene acetic acid 10 parts per million.
4. ∝-naphthalene acetic acid 30 parts per million.
5. No. spray.

Two hundred and fifty branches were used on five multiple-stem trees, 50 branches on each and ten branches per treatment. Only leaves formed previous to the long rains were recorded and each treatment on each tree was adjusted to have approximately 50 leaves, excess leaves being removed at monthly intervals and the effect of the treatments on leaf fall observed.

The Perenox and Phenyl Mercury Fixtan sprays were applied with a paint brush to both surfaces of the leaves and the twigs on 1st May. The hormone (∝-naphthalene acetic acid) treatments were applied in a similar manner but not until growth was slackening on 14th June. Subsequently they were applied each month.

Perenox caused considerably heavier leaf fall than the control. This may possibly have been connected with the bad attack of thrips in March–April which the trees suffered. Phenyl Mercury Fixtan produced slightly heavier leaf fall than the control, but owing to the failure to retain leaves with copper spraying, no conclusions as to whether it could control leaf fall in normal circumstances may be drawn. Both the hormone treatments showed definite decreases in leaf fall rate during the main leaf fall period. This agrees with the hypothesis suggested by previous work that the lack of auxin is the factor which brings about the leaf fall periods.

B—The Effects of Concentration with Blitox and Perenox

This experiment aimed at seeing if any data as to equivalent concentrations of these two fungicides could be obtained using the branch leaf fall technique. The experiment was of similar design to the last except that there were six treatments and 60 branches per tree, giving 360 in all. The treatments were:—

1. Blitox "½%" 0.324 gm. in 100 c.c. water.
2. Blitox "1%" 0.648 gm. in 100 c.c. water.
3. Blitox "2%" 1.297 gm. in 100 c.c. water.
4. Perenox "½%" 0.163 gm. in 100 c.c. water.
5. Perenox "1%" 0.327 gm. in 100 c.c. water.
6. Perenox "2%" 0.654 gm. in 100 c.c. water.

These percentage concentrations are based on the makers' instructions as to concentrations equivalent to Bordeaux mixtures containing these percentages of copper sulphate.

No control was included in the experiment, it being considered that the last experiment would provide evidence as to whether copper treatments reduced leaf fall. As the evidence was in fact to the contrary, no inferences as to the relative value for retaining leaf of the various treatments may be drawn. In fact, in comparison with the graph for control in this first experiment, only Perenox at 1 per cent produced less leaf fall. The difference between the sprays was not large and the results have not been statistically analysed, but the order of leaf fall rate with which they were associated was as follows, starting with that causing the highest leaf fall: Blitox ½ per cent > Blitox 1 per cent > Blitox 2 per cent > Perenox ½ per cent > Perenox 2 per cent > Perenox 1 per cent. This suggests that Blitox was associated with higher leaf fall than Perenox and that more dilute sprays are associated with greater leaf fall than less dilute. Little confidence, however, may be put in these conclusions.

C—Place of Application of Fungicide

The design of this experiment was exactly as in A. 2 per cent Perenox was used and painted on according to the following treatments:—

1. *All over* both leaves and subtending branches.
2. On *upper* surface of leaves only.
3. On *lower* surface of leaves only.
4. On *subtending branch only*, not on leaves.
5. Control.

Once again, none of the treatments produced effective reduction in leaf fall and it is difficult in consequence to form any conclusions. Complete cover produced a markedly higher leaf fall than control, however, whereas painting fungicide on the twigs only produced a slightly lower rate of leaf fall. Treating the lower surface of the leaf produced a slightly higher fall than treating the upper surface, the one being somewhat higher and the other somewhat lower than control. It would seem that the results might be due more to the relative amounts of adverse effect rather than to any beneficial effect on leaf fall.

5. Investigations on "Weak" Spot

During July when fresh "weak" spots were just beginning to appear on leaves formed during the long rains, three attempts at isolating the fungus present in infected mesophyll tissues in the region of the spots were made. A special chamber was designed with glass sides and containing a dissecting microscope, so that dissections of leaves could be carried out under reasonably sterile conditions. The chamber was wiped down internally with spirit and sprayed with spirit previous to commencing operations; the air supply was cleaned by passing through sulphuric acid and liquid paraffin in bubblers. The leaves to be operated on were variously sterilized by wiping over with spirit, by immersion in mercuric chloride in saponin solution and subsequent washing in soap and water followed by sterile water. Under the microscope, the epidermis overlying a "weak" spot was dissected off and cultured, and then the underlying mesophyll tissue was dissected out and cultured separately. In all, 26 pieces of "weak" spot tissue were cultured. In no case did any fungus grow out whatsoever. The contamination rate was very low and what did occur appeared to be due to spores arriving mainly after the cultures were several days old. However, in the first two sets, no growth was also obtained from the epidermal fragments which in view of past work was surprising. Certain modifications were made in the technique so as to reduce any risk of killing fungi in the tissues and in the third set, 60 per cent of the epidermal fragments produced fungi. None of these produced spores and although one species was later persuaded to by growing on a different medium, its identity is not yet known. The absence of the usually very abundant *Colletotrichum* species from these cultures is surprising.

The lack of success in attempting to isolate a fungus from the "weak" spot mesophyll tissues is discouraging, considering the definite microscopical evidence for fungal infection and the more recent evidence of control of "weak" spotting by fungicides (*v.* the investigation under (1) above). Of the two hypotheses suggested in my 1949 annual report (*v.* p. 46), that the fungus in the "weak" spot is dead would seem unlikely in view of the youth of the "weak" spots used in the present investigations, which were only just distinguishable as "weak" spots and would certainly have developed to a much greater size if they had been left untouched. In view of this, the possibility must be actively taken into consideration that the fungus cannot be grown in artificial culture and further work should be directed towards finding the source of infection, which presumably is most likely to be somewhere else on the same bush.

Coffee Berry Disease

Summary of Past Work

A considerable amount of time was spent during the early months of the year going through the old files of the department and the various publications concerned with coffee berry disease, so that a single up-to-date account of all the extensive work which has been carried out on the disease could be compiled. This work is to be published in the January number of the *East African Agricultural Journal* for 1952.

The Upper Kiambu Attack and Survey

Coffee berry disease symptoms were found on Thirlstane and Kimerauli Estates on 26th June and the diagnosis was eventually confirmed by isolating the coffee berry disease form of *Colletotrichum coffeanum*. It is probable that the disease first made its appearance about the third week in May. This was the first record of the disease occurring in the main East Rift area, although it has been known to be in the Nyeri area for a number of years. It was next observed on Kibubuti and Kentmere Estates. In the early stages, only relatively restricted areas were affected, but as ripening approached, more and more coffee became affected. There was a decrease in activity during the drier weather, but further attacks developed during the short rains. As ripening was approached, the Kisii form became predominant and finally brown blight. From berries attacked by this disease, the typical coffee berry disease form of *Colletotrichum coffeanum* developed, thus showing that at least in areas where coffee berry disease occurs, brown blight is caused by the same organism.

In September, the disease was found to be affecting a small area on St. Benoist Estate in Kiambu and subsequently further small areas were found on the same and other Kiambu farms. A survey of the area affected was started in the middle of November. It showed that practically every estate in the Upper Kiambu area was affected, though in most cases the attack was mild and confined to hollows, exposed sites, etc. The heaviest attack was in the area comprising Kentmere, Kibubuti and Thirlstane Estates. From this focus, the attack decreased outwards, even in the north-westerly direction where the coffee grows on higher ground. The lowest estate affected was St. Benoist, though between it and the Upper Kiambu area, numerous small outbreaks were found, forming a broad tongue stretching down in a south-easterly direction from the centre of infection. The Kiambu area comprising Anmer, Kabazi and Kiora Estates had an occasional tree affected, but farther to the north-east no outbreaks were found. The area to the south-west of the Limuru "A" Route road was completely free, although in the Kabete area coffee is growing at the same altitude as in Upper Kiambu. In the lower areas it was frequently noticed that trees of the Harar type were particularly badly attacked and often the attack was confined to these.

Climatic Studies

A rapid examination of meteorological records shows that apart from the heavy rains, the early part of the year in Upper Kiambu was exceptionally cloudy. Thus there would have been exceptionally cold and wet conditions at the time the attack developed. Unfortunately, no temperature or humidity readings are available for the area in 1951, though thermohygrograph records were kept from 1944–46 on Kentmere Estate. The correlation of these with sunshine hours is being attempted in order to get some idea of the conditions which would have occurred at the time of the coffee berry disease outbreak.

Spray Trial

As the effect of spraying fungicides against coffee berry disease is likely to yield basic knowledge on the nature of the disease and as past spray trials have not been of sufficient statistical reliability, a further trial of the effects of spraying was set up on the Kitale Experimental Station. Unfortunately the material available was very limited consisting of a small number of Blue Mountain trees grafted with the very susceptible S.L.14. However, a high degree of attack could be relied upon. The layout is a 5 x 5 Latin Square of rather irregular plot form due to numerous gaps in the stand and there are two trees per plot. The treatments were:—

1. Perenox 1 per cent applied in April, June, August, and October.
2. Tulisan at 2 oz. to the gallon applied at the same times.
3. Mercury Phenyl Fixtan at 4 oz. to 100 gallons, applied at the same times.
4. Perenox 1 per cent applied in August and October.
5. Control.

The sprays were all applied to run-off.

The numbers of berries falling off, attacked with coffeee berry disease or brown blight and ripening without disease were counted. There were no marked effects of spraying, but the data has still to be statistically analysed.

Variety Trials

The variety block on Savani Estate was visited and it is to be rehabilitated. The trees are not yet well enough developed to make reliable observations as to possible resistance to coffee berry disease.

A block of 300 Blue Mountain trees on the Kitale Station has been recorded individually for eight years. These records have been examined by the Agricultural Officer and a number of good cropping trees selected. It is hoped to incorporate their progeny into a variety trial on Savani Estate, Nandi, in due course, for further selection for cropping, quality characteristics and resistance to coffee berry disease.

Infection Studies

Attempts to bring about infection of berries in the field using spores from agar-slope cultures have been carried out in Upper Kiambu both by the writer and Mr. Clinton. In the first attempt, spores were painted on to wounded and unwounded berries with a control of unwounded, uninoculated berries. The "plot" was a single cluster of berries on one node and the "block" a single branch bearing nine "plots". Four branches were treated, two on a susceptible tree with a high rate of coffee berry disease, and two on a tree which was uninfected at the time, but which later developed a little coffee berry disease. The branches were enclosed in polythene bags for a number of days to maintain humid conditions.

13.3 per cent of the 92 control berries, 15.9 per cent (of 85) of those painted with spore suspension, and 80 per cent (of 87) of those inoculated and wounded developed coffee berry disease. The production of the disease by wounding and inoculating is thus well marked, but painting seemed to have little effect. On the tree with no coffee berry disease, however, there was no coffee berry disease on the controls (or on any other berries in this part of the tree) but 8.7 per cent of the 53 berries painted, and 84.8 per cent of those painted and wounded became infected. There is thus some evidence for a slight amount of coffee berry disease being produced without wounding by inoculation with spore suspension alone.

Similar results were obtained in a second inoculation experiment, in which a branch bearing 50 berries (any excess being removed) was the "plot" and all berries on this received the same treatment. The treatments were as before except that an extra wounding without inoculation was added. There were two blocks per tree and two trees (the same as before). On the susceptible tree, the control had 44 per cent coffee berry disease, wounded 34 per cent, painted 47 per cent, and wounded plus painting 60 per cent. For the non-susceptible tree the results were 0, 1 per cent (a doubtful case), 21 per cent and 74 per cent respectively. Thus there was a definite although somewhat low degree of disease attack produced by inoculation without wounding.

In a third experiment carried out by Mr. Clinton towards the end of October, the "plot" was again a branch bearing 50 berries. The treatments were inoculation by painting on a spore suspension, and a control in which sterile water was painted on. These were combined with leaving the branch bagged for three days and for nine to ten days, thus giving four treatments in all. Each treatment was replicated twice and the whole set repeated on a tree with no coffee berry disease at the time and one with a bad attack. On the inoculated branches, a test for infective power of the spore suspension was included by wounding a few extra berries and painting these with the suspension. Coffee berry disease did not appear on any of the experimental branches, except on the wounded berries, during the first 15 days of the experiment, when coffeee berry disease was quiescent in the field. At 30 days, the attack in the field started up again and this also affected the experimental branches, but no difference in disease rate could be detected between the controls and inoculated branches. The lesions on the berries infected by wounding remained small until the disease became active in the field, when they expanded and infected the whole berry.

Thus it appears that inoculation with spore suspension without wounding only produces the disease when conditions are suitable for a general attack in the field. As the inoculated branches were maintained at high humidity, it would appear that the required conditions either relate to temperature conditions, or to the general physiological state of the tree.

Inoculation of leaves of a small potted coffee tree in the laboratory was carried out in late October. Spore suspension was painted on to the halves of four young leaves, half of these being also wounded by puncturing with a needle. The treatments were repeated on four further leaves, using sterile water instead of sport suspension. Brown, necrotic lesions developed on the inoculated halves, whether wounded or not. The leaves wilted, all fell off, and the lesions spread down the leaf stalk. Isolations were carried out and the fungus obtained did not differ essentially from the normal coffeee berry disease form of *Colletotrichum coffeanum.*

Germination Tests and Cultural Work

The effects of varying lengths of desiccation on the percentage germination of spores was studied by Mr. Clinton. Germination, even with spores not allowed to dry out was low, never above 9 per cent. Drying for four hours did not reduce the germination rate, but after 18 hours only 0.2 per cent germinated.

Hyphal tip cultures of several isolations of the coffee berry disease fungus were made and their reactions to growing on different media studied.

Hand Spraying Apparatus

In view of the large amount of coffee spraying which is still carried out by hand apparatus, an investigation of the suitability of the various forms available on the local market was carried out. With regard to "tonic" copper spraying we are unfortunately still in the dark as to the importance of cover, and whether it is essential to apply the spray to the under surface of the leaf or not. However, it would appear likely that an even, under-surface cover is of importance from the evidence so far obtained which indicates that the sprays act through their fungicidal nature. As regards *Hemileia* control, there is no doubt that an extremely good cover of the under-surface of the leaf is necessary. In assessing the various spraying machines, ability to produce a good under-leaf cover has been taken as of great importance.

The following apparatus was examined: Eclipse No. 1 hand sprayer; Dronwal Nos. 1043 and 1042 "Handy spraying outfits"; the Vermorel "Hydra" sprayer, the Mysto "Ladywood" outfit, the "Salva" and "Dronwal" bucket pumps, the Eclipse "Warley" pneumatic, the Dronwal No. 8. "Easy-fill" pneumatic, the "Nesthill" pneumatic, the Mysto pneumatics (several models), the Mysto Knapsack Sprayer No. 3, the "Eclair Plombe" knapsack, the Dronwal No. 1 knapsack, the "Four-Oaks" knapsack, and the "Presto" Spraying Machine (Vermorel). We have to thank the following Nairobi firms for readily agreeing to lend us the apparatus used for the trials: Messrs. J. W. Milligan, Dalgety & Co., J. G. Aronson & Co., G. North & Sons, and Simpson & Whitelaw.

Short tests were carried out in the field in most cases and examination of the under-leaf cover made, using the rubeanic acid test method. General performance and characteristics were noted at the same time, and speed of action, through-put and angle of spray cone determined. Spray deposits were obtained on glass slides and from these studies of the size distribution of the spray spot diameters made. The relation of the diameter of these spots to their volume was determined. The volume was estimated graphically from data on the distribution of depth along the diameter of spots inverted in liquid paraffin on a glass slide as measured by using the graduated fine adjustment on a microscope and focusing on their lower surfaces. In this way the droplet size distribution of the spray could be obtained approximately and the area covered by 1 $mm.^3$ of the spray, when drops do not overlap, could be calculated. This latter figure was found to characterize the fineness of the spray best. Thus the Eclipse "Warley", the "Ladywood" with self-clearing nozzle, the "Hydra" with fine nozzle, the "Eclipse No. 1" with fine nozzle, and the Mysto "pneumatic" all produce sprays of good covering power. On the other hand, in windy weather, a better cover was shown by the rubeanic acid method to be obtained in the field with the coarser sprays owing to their greater "carry".

The nozzles on the knapsack types and the "Ladywood" have high throughputs which for "tonic" spraying at one pint per tree are rather too fast, though this would be advantageous for anti-rust spraying.

Taking all points into consideration, it seemed that the "Hydra" was probably the best apparatus. It is relatively cheap, sturdily constructed, has good cover and the through-put is relatively rapid. The continuous action makes pumping much easier and less tiring and this means more attention can be given to directing the spray on to the bush. The angle of cone could, however, be wider with advantage.

There would appear to be an opening for a "wheelbarrow" type of spraying apparatus in coffee. None is available in the country and as transport would add considerably to the cost of an imported article, investigations are under way to see if they might be made locally.

Growth Control by Maleic Hydrazide

The experiments described last year and carried out in the short rains of 1951, using in the case of spraying of whole trees a set of six pairs of trees randomized as to which of the pair received the spray.

The spray used was in the form of the ethanolamine salt of maleic hydrazide and I have to record my great indebtedness to Dr. Templeman and to Imperial Chemical Industries who prepared the material especially for these experiments. The spreader "Agral LN" was added to the sprays before use. In the case of the spraying of whole trees the spray was made up to contain the equivalent of 0.4 per cent maleic hydrazide.

Assimilation was again measured by the leaf punch method at monthly intervals. The values obtained in any one month were very variable, the coefficient of variation amounting to over 110 per cent. In consequence, only very great differences in the monthly figures would have reached significance and although in August the figures for assimilation of the sprayed trees were only a quarter of the unsprayed and in September they were three times as high, these differences were not statistically significant and actually the average figures for the period June to November were practically the same. There is thus no evidence that the maleic hydrazide interfered to any great extent with assimilation, that is to say that it reduced it to near zero, but there may have been quite a large effect without the experiment detecting it.

The effect on growth was very marked and was first noticeable about mid-July, when the unsprayed trees began to grow vigorously, whereas many branches on the sprayed trees ceased to grow completely and there were numerous cases of small-scale die-back affecting the youngest two or three nodes. The effect lasted until October, when those branches which had not died back started to grow again, though the greater part of the trees' growth was now in the form of laterals, which had made their appearance close behind the growing region of the primaries. A count of the number of laterals on the last three living nodes of 15 branches chosen at random on each tree, showed 14 times as many on the sprayed trees as on the unsprayed. The number of flower buds in this same region was also slightly higher, but not significantly so. A count of suckers showed them to be over twice as abundant and a score for vigour showed them to be more vigorous. The spray thus shows promise for inducing suckering at the end of a cycle in multiple-stem coffee and might be tried in areas where difficulty in obtaining suckers is experienced. As a method of inducing branching in the neck region of multiple stem and thus reducing the liability of this part of the bush to die-back owing to its tendency to low leaf-to-crop ratio, the spray is worthy of further investigation.

In the trial of concentrations on individual branches, the sprays contained the equivalent of 0.2 per cent, 0.4 per cent and 0.8 per cent maleic hydrazide and were applied on 19th May. By the middle of the next month, growth inhibition was beginning to be apparent and by mid-July it had been reduced to zero, though the controls were growing quite vigorously and continued to do so until mid-October. The branches sprayed with the 0.4 per cent and 0.8 per cent solutions did not produce further growth during this period, but there was a very slight growth on the branches treated with the 0.2 per cent spray. The concentrations used last year are thus seen to have been rather on the low side (0.1 per cent, 0.2 per cent and 0.3 per cent were used) but the lack of response observed then was probably due to using the pure substance rather than the ethanolamine salt and to omitting a wetter from the spray.

In view of the reported possibility of maleic hydrazide being a carcinogen, investigations will be discontinued until this is confirmed or otherwise.

Bricky Flavour in Coffee Liquor

In view of the results obtained last year, field experiments were set up in co-operation with Messrs. African Explosives and Chemical Industries firstly to confirm whether the benzene hexachloride-containing insecticides were definitely involved and secondly to see whether any of them, especially the purer forms with less odour, might not produce the bricky flavour. Different times of application were also tried.

The trial consisted of two replications of a 12-treatment randomized block, repeated on three places: at the Coffee Research Station, on Ruiru Mills Estate and on Kibubuti Estate, Kiambu (14 treatments here). Several pickings were made and two samples of A + B grade (sometimes A + B + C) from each plot and picking submitted to the Coffee Board's Liquorer, Mr. Devonshire, for liquor description. The treatments were as follows:-

1. Agrocide 3 applied as a "ring" dusting round the base of the tree at the end of March, again at the end of June, and again at the beginning of September (10th October on Kibubuti).
2. The same in March only.
3. The same in September only.
4. Agrocide 7 as a "ring" dusting in March only.
5. The same in September only.
6. Agrocide wettable powder applied as a spray one month before picking.
7. The same applied two months before picking.
8. YF 2340 (similar to the last, but purer) as a spray one month before picking.
9. The same applied two months before picking.
10. The same applied both one and two months before picking.
11. Insect powder (purer than Agrocide 3 and 7) as a "ring" dusting as in treatment 1.
12. Control.

At Kibubuti two extra treatments, Gammalin spray applied one and two months before picking, were added.

Complete results are not yet available but those to date have completely confirmed that "bricky" flavour is produced by B.H.C. compounds and indicates that Wettable Agrocide is the worst, closely followed by YF 2340. Agrocide 7 is also clearly indicted.

Our sincere thanks are due to Mr. Bockett of Ruiru Mills and Mr. Selby of Kibubuti Estate for granting us facilities to carry out these experiments.

Growth Recording

Growth recording has been commenced at the Coffee Research Station, where the effects of multiple stem as against single stem, shading and irrigation are to be studied in a factorially designed experiment with two replications, the plots being divided to study the effect of stripping. The plots consist of eight trees, in a double row, but only the centre four are used for growth records. So far, only the stripping treatment has been applied, recording starting in March. There were two almost equally marked growth periods in the long rains and the short rains respectively. Growth remained at a fair level during June, July and August. Stripping did not produce any very marked effect on the growth rate, the stripped trees growing rather less during the maximum growth periods, but rather more during June to August. In July when "hot and cold" disease made its appearance on the cropping trees, it was absent from the stripped ones. This observation demonstrates the effect the physiological state of the tree has on the development of this condition.

The growth records of the trees at the Scott Laboratories (Kabete) show a somewhat different pattern from those from the Coffee Research Station. The long rains growth was more marked and the short rains less, and about a month later. In August–September, a small growth period occurred. The watered trees showed a pattern similar to that of 1943 by ascending to a maximum in February and then gradually and irregularly falling to December. The maximum during the long rains was considerably lower than that of the unwatered trees. This different behaviour from other years is most probably due to the higher atmospheric humidity operative.

The soil moisture records show that the poor rains of 1950 were followed by a period of extremely dry soil conditions in January–February, 1951, and on the unwatered block farthest from the watered trees, the 9-ft. level had already dried out in November, the short rains only wetting the topsoil. From mid-December to the break of the long rains in the second week of March, there was no available moisture registered in this block: In the second block next to the watered trees, the position was not quite as extreme, but here even the 15-ft. level began to show incipient drying for the first time since recording started. All the profiles were wet by the third week in May and with the heavy rains which fell, remained so until September. When the short rains broke at the end of October, there was still available moisture at all levels except in the topsoil. Following the rains, the soil remained wet until mid-January.

At Solai, the pattern of growth differed considerably from that obtained last year and resembled the normal East Rift picture in that there were separate long rains and short rains periods with a minimum growth period in between. It is noteworthy that this latter was also a period of heavy leaf-fall as in the main East Rift areas.

Miscellaneous Investigations

In connexion with the investigation of a block of unthrifty coffee on "Closeburn" Estate, four root systems were excavated and found to have very poorly developed axial systems. The coffee appeared to have been planted too deeply. There may have been some indirect action of the deep planting on the development of the axial system.

Dr. Jex-Blake arranged for a 32-ft.-deep hole to be excavated on Kyuna Estate, Kabete, to follow the depth to which the coffee root systems penetrated. The author traced the latter to 14 ft., the deeper roots penetrating the subsoil mainly in large root traces from old forest trees, now filled with a little earth and decaying organic matter. The hole gave an opportunity to study a complete profile down to rotten rock.

Berry fall was abundant this year on most East Rift estates. In part this was due to competition of early crop with late and in part may also have been a reflection of abnormally moist conditions. It was particularly bad in the Upper Kiambu area and its occurrence in a year when there was an outbreak of coffee berry disease may not entirely be a coincidence and should be borne in mind.

Other investigations included an outbreak of leaf disease following repeated spraying in the Mitubiri area, lightning damage on a number of estates and root rot due to fungal attack associated with old rotting shade tree stumps in Kiambu.

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ANNUAL REPORT OF THE AGRICULTURAL CHEMIST (COFFEE SERVICES), FOR 1951

The greater part of my time, in both laboratory and field, was allotted to physical studies of soil structure, infiltration of rainfall, and storage of soil moisture. These measurements were made under the controlled conditions of field trials, and included further samplings of soil moisture conditions of field capacity and wilting point throughout the root range of coffee, both mulched and unmulched, and of the appropriate fallow comparisons. Changes in soil structure and infiltration rates were measured after different periods of elephant grass ley and in the range of soil conditions produced by the large cultivation trial. Field run-off sampling and applications of artificial rainfall in the laboratory to soil cores of undisturbed structure were employed to study these structural differences. Measurements of open water evaporation from both sunken and raised tanks, radiation, wind speed and other meteorological factors were continued as part of these water-balance investigations.

The main soil fertility trials, conducted jointly with Mr. Jones, were statistically analysed and the results were studied in greater detail at the end of 1951, since five crop seasons had then covered the whole range of rainfall conditions characteristic of the area; these studies have been submitted to the *Empire Journal of Experimental Agriculture.*

Chemical work was restricted to organic matter determinations on soil crumbs, and to routine checks on the nutrients applied in the treatments of the mulching and manuring trials.

A tour of experimental coffee areas west of the Rift was carried out in February in company with Messrs. Rayner and Jones. This tour included a most interesting liaison visit to the new Tea Research Institute at Kericho.

The following are brief notes on the progress of some of the work quoted above:—

Rainfall Observations.—1951 was an unusually wet year, the total rainfall being more than twice that received in 1950. A study of the local variation in rainfall was begun by siting a line of six standard 5-in.-diameter gauges along the main ridge of the 380-acre estate. The highest gauge, No. 6, is some 70 ft. above the lowest, No. 1, and distant three-quarters of a mile from it. Gauges Nos. 2 and 3 are placed together, but No. 3 is surrounded by a sloped embankment in order that turbulence caused by the body of the gauge should not disturb the air-flow across the mouth.

The annual totals were:—

Gauge	6	5	4	3	2	1
Inches	56·99	57·47	57·17	56·18	56·33	54·05
Wet days	200	200	203	204	204	165

Thus the readings of single rain gauges differ by 3.42 in. and 39 wet days in the year. The largest discrepancies occurred in mid-rains, differences of over 1 in. being recorded for the monthly rainfall in May, June and November. This local variation is important when considering rainfall records of individual coffee estates, taken from single rain gauges.

Soil Moisture Availability.—Evaporation from open water in a 4-ft.-diameter sunken tank amounted to 61.36 in. during the year, which was only 5 in. in excess of rainfall received by the nearest gauge.

The effect of moisture conservation by grass mulching would be expected to be of less importance in so wet a year. The number of days during which water and nutrients were available to the dense surface root mat of coffee were observed both by weekly soil sampling and by daily observations of electrical resistance of gypsum absorption blocks. The data for the soil between the 6-in. and 9-in. depths is summarized in Table 1, 9 in. being approximately the total depth of topsoil in the area studied, and 6 in. the greatest depth of cultivation.

TABLE 1—DURATION IN DAYS OF AVAILABLE MOISTURE
(PERCENTAGE OF YEAR IN PARENTHESES)

	Fallow	Coffee
Bare Soil	225 (61·6%)	180 (49·0%)
Grass Mulch ..	305 (83·6%)	310 (84·9%)

The losses by evaporation from the soil surface reduce the 6–9-in. zone to wilting point very nearly as rapidly in fallow as under the mature multi-stem coffee. The latter affords little effective shade to the soil surface. Thus in spite of an exceptionally favourable year in which rain fell on 165 days, the mulched coffee has been able to benefit by an extra one-third of a year of available moisture in this important horizon of well-aerated topsoil. The advantage from this extra soil moisture was measured as a 75 per cent increase in crop yield.

Restoration of Structure in an Eroded Coffee Soil.—When the Jacaranda Estate was purchased in 1944 a strip of coffee about 25 acres was considered too poor for improvement by good husbandry and was scheduled for uprooting. This coffee lay in a long, narrow strip along the western flank of the main ridge of the estate. Some 18 in. of the topsoil had been lost by past erosion, leaving only 3 in. of loose, red dust, overlying the typical Kikuyu Red Loam subsoil, whose depth exceeded 10 ft. at the shallowest point. The coffee was scheduled for uprooting at three acres per year, and each block was to be planted with elephant grass (*Pennisetum purpureum*) for two or three years to improve the

soil structure before being replanted with improved varieties of coffee. Four such three-acre blocks were in fact planted with elephant grass. The first of these was replanted with coffee after two years. The programme, which had been in the nature of an empirical demonstration, was suspended in 1949 in order to use the rest of the area for a 2° field trial of soil and crop improvement by grass mulches, manures and fertilizers, applied to the original coffee. In 1951 there were substantial areas representing six stages in this simple coffee-grass-coffee rotation, together with plots which had received a 6-in. all row grass mulch for two successive years. These seven soil conditions were sampled in the dry weather of February, 1951, by taking both 4-in.-diameter sleeved cores and numerous loose soil samples from the first 3 in. of surface soil.

The physical condition of the soil was then estimated by a number of independent measurements. After vacuum saturation of the cores, percolation rates under static head were measured. The proportions of free-draining pore-space were determined on tension tables, and the cores were then each subjected to 1 in. of artificial rainfall of a controlled drop-size of 6 mm. diameter in a period of ten minutes. The proportion of this rain which percolated through the core was taken as an estimate of the most useful effect of soil structure.

The loose soil samples were passed through a mechanically shaken bank of sieves for dry aggregate analysis, and sub-samples were reassembled so that each contained the correct proportion of dry crumb sizes, before being vacuum-wetted and sieved under water by a mechanical oscillator which gave a quarter-rotation of the sieves for each stroke. The full results of this detailed study are being submitted as a scientific paper, but the main conclusions are best illustrated by Fig. 1. This shows the percolation under the impact of artificial rain.

The effects of the elephant grass are very striking, and after five years there was almost 100 per cent efficiency in the absorption of rain at 6 in. per hour on a flat surface of bare soil (C). The substantially lower structural efficiency of the grass in the sixth year is due to the reduced stand of elephant grass following a severe invasion by "couch" (*Digitaria abyssinica*) and the cultivations required to suppress it (D).

The very high structural efficiency (E) achieved by two years of thorough grass mulching shows clearly that it is not necessary to uproot the coffee in order to improve the soil structure, and that, even if the coffee is to be replaced by better varieties, this may be done immediately, with heavy mulching, instead of after an expensive delay of several years.

The very rapid loss of soil structure when grass leys are broken for cultivation under Ruiru conditions is also well illustrated (F, G). After two years of grass improvement followed by four years of normal cultivation of young unmulched coffee, it is surprising to find the soil to be in a poorer condition than that of control, but this effect was shown consistently by all five methods of estimate of structure. This confirms observations of the effects of breaking Rhodes grass paddocks on this estate, and suggests that, for efficient use of rainfall, not more than two successive years of arable crops should be taken in the rotation.

Inches of Percolating Water
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
A
Control
Coffee Soil in
Dusty Condition.
B
Elephant (Napier) Grass Ley for Four Years.
C
Elephant (Napier) Grass Ley for Five Years.
D
Elephant (Napier) Grass Ley for Six Years.
E
Grass Mulch Between Coffee Trees for Two Years.
F
Elephant Grass for Four Years Followed
by New Coffee Clean Cultivated
for Two Years.
G
2 Years' Grass
and 4 Years
Coffee
Cultivation.

Volume of Roots produced by Elephant Grass (Napier Grass, *Pennisetum purpureum*).—In the structure studies described above, the binding effect of the grass rootlets was observed to produce the main effects of aggregation. The disappearing of these rootlets by oxidation in the hot, dry soil conditions produced by clean cultivation was accompanied by a rapid decline in soil structure. For further information an estimate of the volume and distribution of the roots of elephant grass was attempted. In an even stand of seven-year-old grass, two pits were dug to expose faces 10 ft. deep and 6 ft. wide. Roots were washed out by a water spray and observed to be very dense in the first foot, numerous to a depth of 7 ft., after which a sparse but even distribution of roots appeared to penetrate well beyond the 10 ft. exposed. Soil was then removed in a 6-in. layer from unsprayed sections of the face, a square foot at a time, from three complete profiles. The soil from each square-foot section was then stirred in a slow stream of tap-water in a four-gallon drum provided with an overflow spout near the top. Roots and soil in suspension were carried over, and the roots were collected on a ½-mm. sieve. The root volumes were determined by displacement of water in a graduated flask, and approximate fresh weights were obtained after removing the surplus water by pressing between sheets of blotting paper.

Cubic Inches of Roots per Cubic Foot of Soil

Profile Depth	A	B	C	Means	Approximate fresh weight of roots
Results					
0–1 ..	50·8	28·7	66·6	48·7	34 tons per acre
1–2 ..	8·4	12·4	18·8	13·2	
2–3 ..	5·8	8·4	10·1	8·1	
3–4 ..	4·8	5·0	5·0	4·9	
4–5 ..	4·5	5·0	3·1	4·2	30 tons/acre.
5–6 ..	3·6	5·0	2·2	3·6	
6–7 ..	2·8	2·5	2·2	2·5	
7–8 ..	3·8	2·2	2·7	2·9	
8–9 ..	2·	3·0	2·2	2·6	

The figures are quoted in order to illustrate the distribution rather than the real volume of elephant grass roots in this Kikuyu Red Loam soil; actual root volumes, including the root hairs, are probably much larger. The importance of this root mat on the moisture relationships in a rotation was well illustrated by soil sampling carried out in March, 1951, when the soil under mature elephant grass was found to be at the wilting point for each foot of the first 10 ft. of the profile. These wilting points are known accurately from laboratory determinations. The total soil moisture deficit for the 10 ft. was almost exactly 9 in., i.e. this amount of rain was required to restore the soil to the condition observed by previous sampling after a period of rain.

Thus, if elephant grass is cleared in dry weather, and the area planted with a new crop at the onset of the next rains, any interruption in rainfall may lead to loss of crop.

H. C. PEREIRA.

ANNUAL REPORT OF THE PASTURE RESEARCH CHEMIST, 1951

The nature of the work undertaken may be reviewed under three headings:—

1. Chemical analysis of herbage, complementary to a series of co-operative field experiments.
2. Limited reconnaissance surveys in selected areas.
3. Miscellaneous analysis of herbage species, including legumes.

Reconnaissance Surveys.—Surveys of a limited nature were made with the object of examining and recording in topographical sequence, the characteristics of certain soils and the vegetation they support. Such surveys were made on the Grassland Stations at Molo, Kitale and Ol Joro Orok. Soil and vegetation in topographical sequence were studied also at Fort Ternan and Sotik. In all instances soil samples collected during the surveys were subsequently analysed by the Soil Chemist.

Miscellaneous Analysis.—The results of determinations made on several different legumes and one grass, may be given appropriately under this heading, and are recorded below:—

RESULTS BASED ON 100 PER CENT DRY MATTER

Herbage	Stage of Growth	Locality	Crude Protein	Fibre	CaO	P_2O_5
Pennisetum clandestinum	Tall, leafy ungrazed ..	Kageera Est. Limuru	19·56	23·26	0·59	0·53
,,	Very short, closely grazed	,,	13·59	23·68	0·69	0·33
,,	Leafy herbage ..	Karirana Estate ..	11·20	n.d.	0·85	0·31
,,	,,	Limuru	13·39	n.d.	1·02	0·38
Vigna schimperi	Late flowering (leaf) ..	Ol Joro Orok ..	24·07	15·30	3·06	0·77
,,	Late flowering (stem)	,,	22·26	38·25	1·19	0·72
Glycine javanica	Early flowering (leaf)..	,,	26·49	21·77	2·33	0·77
,,	Early flowering (stem)	,,	14·26	37·31	1·48	0·71
Dolichos lablab	Flowering and podding (leaf and stem) ..	Kitale	22·70	28·72	2·15	1·74
Indigofera subulata	Early flowering (leaf)..	S.A.L.	34·49	11·46	5·27	0·66
,,	Early flowering (stem)	S.A.L.	17·76	26·71	2·24	0·55
Ornithopus sativus (*Serradella*)	Early podding (leaf and stem)	Ol Joro Orok ..	11·19	25·61	1·88	0·59
,,	Full flowering (leaf) ..	Ol Joro Orok ..	17·71	19·34	2·81	0·53
,,	Full flowering (stem)..	Ol Joro Orok ..	7·45	35·09	0·91	0·50

The samples of *Pennisetum clandestinum* from Kageera have shown a marked difference in their content of crude protein, the ungrazed leafy material being much richer in this constituent than the closely grazed herbage. The crude fibre content of both samples was almost identical while phosphoric oxide was much lower in the shorter herbage.

The Karirana samples, while having a crude protein content similar to that of the closely grazed material from Kageera, were well supplied with lime, but low in phosphoric oxide.

The legumes, it will be noted, were taken for analysis at a somewhat mature stage of growth and, with the exception of *Dolichos lablab*, the composition of their leaves and stems was determined separately. The crude protein and lime constituents of the leaves were commendably high, crude fibre relatively low, and phosphoric oxide reached a very respectable level. The stems were markedly more fibrous than their leaves but their mineral components were at a very satisfactory level and crude protein, especially in the case of *Vigna schimperi*, was high. The composition of Serradella would not appear to compare favourably with other legumes sampled at very much the same state of maturity.

Field Experiments.—A limited number of experiments conducted by the Highland Fertilizer Scheme in 1950 indicated beneficial effects of phosphate on ley establishment and promising responses to nitrogen from established grass, whether in leys or natural pasture: potash and lime appeared to have no appreciable effect. It was decided to carry out a large number of small-scale "cutting" trials, using nitrogen and phosphate only, in order to—

(1) study the effect of a deliberately wide range of rates of application and thereby obtain a preliminary assessment of optimum dressings;

(2) determine the response to N and P, as measured by the productivity and nutrient value of the herbage, on different soils in areas of varying altitude and climate.

Accordingly 34 newly sown ley experiments and 26 permanent grassland experiments were laid down on a co-operative basis on farms in the European Highlands ranging from Mount Elgon to the Kinangop.

For permanent grassland, factorial combinations of sulphate and ammonia and single superphosphate were arranged in the form of a quasi-Latin Square with 18 treatments twice replicated. The fertilizers were applied at the following levels—

sulphate of ammonia: 0, ¾, 1½, 3, 4½, 6, cwt. per acre;

superphosphate: 0, 2, 4, cwt. per acre;

and were broadcast at the beginning of the growing season. Sulphate of ammonia was reapplied at the appropriate level after each herbage cut had been taken. For leys to be established, factorial combinations of the same fertilizers, involving 16 treatments, were arranged in two blocks. Fertilizers were applied to the seed bed only at the following levels:—

Sulphate of ammonia: 0, 1½, 3, 6, cwt. per acre.

Superphosphate: 0, 2, 4, 8, cwt. per acre.

Rhodes grass, molasses grass, cocksfoot and Kentucky fescue were each combined with the legumes lucerne and Serradella.

The herbage in both types of experiments was cut at periodic intervals throughout the season when it had reached a stage of growth considered suitable for stock grazing. Yields of fresh material were recorded and samples taken for dry matter determinations and chemical analysis.

Soil reaction, as measured by pH values, was obtained for each plot of each experiment prior to the initial application of fertilizers and after each herbage cut, but, in the case of permanent grassland, before reapplication of sulphate of ammonia. A late sampling for pH determinations was also made in December.

An unfortunate but inevitable time-lag is to be expected between the accumulation of field data and complementary laboratory data: in the account which follows, therefore, when reference is made to herbage analysis, it is in relation only to the composition of material derived from the first cut. The number of experiments used to illustrate any point are, however, given where necessary.

The data so far obtained has provided evidence to suggest that while the botanical composition of a sward and the stage of maturity at which it is cut are important factors concerned in the production of herbage, considerable variation in the productivity of the same species may be expected under different conditions of soil and climate. Tables I and II produced below summarize the results of all experiments in terms of dry matter production per acre.

*Table I—Newly Sown Leys

Mean of 34 *Experiments and* 68 *Cuts*

Yield in Tons Dry Matter per Acre

	P0	P2	P4	P8	Mean
N0	0·53	0·72	0·79	0·82	0·71
N1½ ..	0·58	0·81	0·88	0·99	0·81
N3	0·65	0·88	0·98	1·06	0·89
N6	0·61	0·98	1·01	1·10	0·92
Mean ..	0·59	0·84	0·91	0·99	

*Table II—Permanent Grassland

Mean of 26 *Experiments and* 61 *Cuts*

Yield in Tons Dry Matter per Acre

	P0	P2	P4	Mean
N0	0·69	0·80	0·85	0·78
N¾	0·91	1·01	1·04	0·98
N1½	1·05	1·23	1·29	1·19
N3	1·31	1·47	1·57	1·45
N4½	1·40	1·73	1·86	1·66
N6	1·55	1·77	1·88	1·73
Mean	1·15	1·33	1·41	

Response to nitrogen in respect of permanent grassland follows a logarithmic curve given by the formula—

$$Y_x = 1.93 - 1.15x^{-0.713x}$$

where x represents cwt. nitrogen per acre.

(*In Tables which follow, L and P will connote Ley and Permanent Grassland respectively.)

Response curves to phosphate in respect of permanent grassland and leys resemble those given by Crowther & Yates in the *Empire Journal of Experimental Agriculture* (Vol. IX, 1941) for root and cereal crops. In the case of newly sown leys response to phosphate follows a curve given by the formula—

$$Y_x = 0.59 + 0.42\ (1-10^{-1.11x})$$

where x represents cwt. P_2O_5 per acre.

Applications of increasing levels of a nitrogenous fertilizer, in the form of sulphate of ammonia, have been found substantially to increase the yield of dry matter from both newly sown leys and permanent grassland and, at the same time, influence favourably the crude protein content of the herbage.

From Tables III and IV it will be seen how, on a dry matter basis, yields of crude protein per acre may be correlated with increasing levels of nitrogen.

TABLE III (L)

mean of seven experiments

ADDED N	CRUDE PROTEIN
lb. per acre	*tons per acre*
0	0·102
30	0·123
60	0·135
120	0·169

linear correlation

r=0·997 Sign. 0·01

TABLE IV

mean of three experiments

ADDED N	CRUDE PROTEIN
lb. per acre	*tons per acre*
0	0·138
15	0·170
30	0·203
60	0·194
90	0·257
120	0·315

linear correlation

r=0 952 Sign. 0·01

For newly sown leys, the general effect of added nitrogen has been to cause a depression in the lime (CaO) content of the herbage: this effect has not been demonstrated, however, in respect of permanent pastures.

No evidence has been obtained to suggest that added nitrogen in any way affects the phosphoric oxide (P_2O_5) content of herbage, either from newly sown leys or permanent grassland.

It is a well-known principle that an effect of adding sulphate of ammonia to a soil is for a base-exchange reaction to take place in which ammonium ions enter the exchange complex and an equivalent amount of other base, usually calcium, is displaced. This displaced calcium is usually leached from the soil in association with the sulphate ion of the fertilizer, thereby eventually causing a reduction in pH. This effect has been demonstrated both in the soils of newly sown leys and permanent pastures, as the following tables show:—

TABLE V (L)

mean of eleven experiments

ADDED N	pH
lb. per acre	
0	5·49
30	5·47
60	5·43
120	5·38

negative linear correlation

r=—0·993 Sign. 0·01

TABLE VI (P)

mean of nine experiments

ADDED N	pH
lb. per acre	
0	5·85
15	5·84
30	5·76
60	5·66
90	5·62
120	5·55

negative linear correlation

r=—0·983 Sign. 0·001

It has been estimated, and generally agreed amongst European and American workers, that the application of 1 cwt. sulphate of ammonia (20 lb. N) to a soil increases the loss of lime by 0.8 cwt. CaO or 1.5 cwt. $CaCO_3$. It would seem desirable, therefore, that this depletion of a soil's lime status be kept in mind in circumstances where repeated heavy dressings of a nitrogenous fertilizer are to be applied to pastures.

Results obtained from permanent grassland suggest that from the viewpoint of productivity, there are advantages in applying nitrogen at intervals throughout the growing season. With newly sown leys, a single dressing to the seed bed in adequate amount usually can be beneficial, but after the herbage is cut for the first time, little or no measurable residual effects have been obtained, even from the highest rate of application. It is possible that when applied at somewhat extravagant levels at the time of seeding down a ley, the fertilizer may be largely wasted either by mechanical leaching or because a juvenile rooting system is not fully capable of utilizing that proportion of the fertilizer which has entered the soil's exchange complex.

It is tentatively suggested that optimum dressings of a nitrogenous fertilizer for permanent grassland may be in the order of 60–80 lb. N, possibly with advantage supplied in three equal dressings of 20–25 lb. during the course of a growing season. For newly sown leys, a dressing of 30 lb. N given at the time of seeding down probably would be adequate.

Available information has suggested that applications of different levels of a phosphatic fertilizer, in the form of superphosphate of lime, may be expected to increase the yield of herbage from newly sown leys and permanent grassland. Chemical analysis, however, has shown that whereas in regard to permanent grassland, the crude protein content of the herbage is influenced favourably, this constituent may be depressed frequently in the case of newly sown leys. In both circumstances, however, added phosphate has promoted an increase in the total output of crude protein in the dry matter per acre, as can be seen from an output of crude protein per acre, as can be seen from an examination of the following tables:—

TABLE VII (L)

mean of seven experiments

ADDED P	CRUDE PROTEIN
lb. P_2O_5 per acre	*tons per acre*
0	0·064
36	0·139
72	0·155
144	0·159

r=0·795 positive response curve

TABLE VIII (P)

mean of three experiments

ADDED P	CRUDE PROTEIN
lb. P_2O_5 per acre	*tons per acre*
0	0·165
36	0·217
72	0·258

positive linear correlation

r=1·00 Sign. 0·001

It might be anticipated that applications of a phosphatic fertilizer would contribute to the nutritive value of herbage, as reflected in its P_2O_5 content and, in fact, this has been shown to be the case.

TABLE IX (L)

mean of seven experiments

ADDED P	P_2O_5
lb. P_2O_5 per acre	*In dry matter*
0	0·51
36	0·57
72	0·60
144	0·67

positive linear correlation

r=1·03 Sign. 0·001

TABLE X (P)

mean of three experiments

ADDED P	P_2O_5
lb. P_2O_5 per acre	*In dry matter*
0	0·40
36	0·52
72	0·55

positive response curve

r=0·905

When the ratio crude protein: P_2O_5 content of dry matter was considered in relation to added phosphate, however, a negative correlation was obtained. as may be seen below:—

TABLE XI (L)

mean of eight experiments

ADDED P *lb. P_2O_5 per acre*	RATIO *Crude Protein: P_2O_5*
0	31·31
36	28·64
72	26·04
144	23·10

negative linear correlation
r = −0·987 Sign. 0·01

TABLE XII (P)

mean of three experiments

ADDED P *lb. P_2O_5 per acre*	RATIO *Crude Protein: P_2O_5*
0	27·71
36	21·80
72	19·79

negative correlation curve
r = −0·962

For sown leys, the general trend with added phosphate has been to cause a depression in the ash content of the herbage and also in the lime component of the ash. On the other hand, in the case of permanent grassland, the lime content of the herbage appeared to have benefited slightly by added phosphate, viz.:—

TABLE XIII

mean of nine experiments

ADDED P *lb. P_2O_5 per acre*	CaO *In dry matter*
0	0·89
36	0·81
72	0·73
144	0·78

TABLE XIV

mean of four experiments

ADDED P *lb. P_2O_5 per acre*	CaO *In dry matter*
0	0·69
36	0·76
72	0·77

It was observed that where added phosphate tended to depress the CaO content of the herbage, pH values of the soil were relatively high; where, on the other hand, pH values were relatively low, the calcium content of the herbage usually was enhanced. The following examples, taken from newly sown leys, are given:—

TABLE XV (L)

	ADDED P—lb. P_2O_5 per acre				
	0	36	72	144	pH
CaO content of D.M...	1·20	1·26	1·32	1·54	4·8
,,	0·62	0·65	0·67	0·70	5·0
,,	1·30	0·72	0·72	0·71	5·5
,,	1·07	1·01	0·83	0·90	6·5

A postulation by Dr. E. M. Crowther may offer some explanation in this connexion. Crowther has stated that "the addition of monocalcium phosphate to a soil must involve the removal of some Ca from the exchange complex—or CaCO3 if present—to form more basic and insoluble calcium phosphate which may be regarded as $Ca_3P_2O_8$ although there is some indication that only a still more basic salt is sufficiently stable to remain indefinitely in the soil. But the extra calcium removed from the complex is not lost from the soil and is

probably still available to plants and capable of contributing to the buffer capacity of the soil". It may be reasonable to infer that in circumstances of acid soils the Ca liberated from the complex either by superphosphate or sulphate of ammonia is in fact being utilized to some extent by actively growing grass, but with soils moderately acid or approaching neutrality in reaction, the calcium may take part rapidly in a reaction leading to the formation of insoluble dicalcium phosphate on the surface of clay particles, viz.: $Ca(H_3PO_4)_2 + Ca \rightarrow 2CaHPO_4$, or be leached from the soil as calcium sulphate.

That added phosphate has not been demonstrated to affect soil reaction adversely may perhaps lend support to Crowther's "buffering" hypothesis. The following tables are given by way of illustration:—

TABLE XVI (L)

mean of thirteen experiments

ADDED P *lb. P_2O_5 per acre*	pH
0	5·54
36	5·54
72	5·56
144	5·57

TABLE XVII (P)

mean of four experiments

ADDED P *lb. P_2O_5 per acre*	pH
0	5·71
36	5·69
72	5·68

For permanent grassland, an important aspect to soil reaction in relation to added phosphate is shown in the following tables where it will be seen that in terms of yields of fresh material, greater responses over the control have been obtained from soils of relatively low pH.

TABLE XVIII (P)

(FIRST CUT)—ADDED P lb. P_2O_5 per acre			(MEAN OF 3 CUTS)—ADDED P— lb. P_2O_5 per acre		
pH	36–(0)	72–(0)	36–0	72–0	pH
6·66	0·18	0·18	0·14	0·18	6·66
6·54	−0·16	0·01	−0·13	−0·07	6·37
6·34	1·13	1·71	0·14	1·38	6·29
6·27	0·18	0·16	0·48	0·19	6·13
5·95	0·77	1·29	1·03	1·38	5·95
5·86	1·75	2·10	0·52	0·65	5·66
5·82	0·62	0·39	0·04	0·35	5·64
5·66	0·07	0·62	0·79	1·50	5·53
5·59	0·86	1·45	0·71	0·98	5·52
5·50	1·36	1·57	1·59	1·61	5·44
5·35	1·37	0·95	0·87	1·42	5·41
5·11	2·39	2·55	1·17	1·54	5·09
negative linear correlations			negative linear correlation		
r=−0·829		r=−0·587	r=−0·734		r=−0·670
Sign. 0·001		Sign. 0·05	Sign. 0·01		Sign. 0·02

It will be observed that the degree of significance is less pronounced at the higher levels of phosphate application. No parallel correlation has been found in respect of newly sown leys. Should such a correlation exist, it is unlikely that it will become known without careful reference to previous cropping history and manuring of each individual site, supported by a determination of percentage base saturation and of P_2O_5 status for each soil.

As assessed from the evidence available, it would appear that optimum dressings of a phosphatic fertilizer for newly sown leys and permanent grassland should rarely be required to exceed 54 lb. P_2O_5 per acre. Under the conditions of the present series of experiments, phosphate was applied in a single dressing. Whether the same amount of phosphoric oxide could be given to advantage in more than one proportionally smaller dressing is at present being examined. In terms of dry matter production, little or no residual effects have been found to accrue from a single dressing of phosphate given at the time of seeding-down leys, although small residual effects were sometimes obtained from permanent grassland where, it will be recalled, more than one dressing of nitrogen had been applied. From the viewpoint of nutritional value of the herbage, however, some evidence has been obtained to indicate that the phosphoric oxide content in the dry matter may remain enhanced nevertheless, as a result of a single, initial dressing.

In temperate climates it is usual to assume that a protein-rich herbage will be in all probability a relatively mineral-rich herbage. The following table, representing the means of nine experiments, illustrates a relationship which has been found between the mineral-containing ash and crude protein content in the dry matter of herbage from both newly sown leys and permanent grassland:—

Table XIX (L and P)

Ash	Crude Protein
In dry matter	*In dry matter*
17·56	20·49
17·42	16·19
15·89	18·29
15·73	19·06
15·49	19·67
9·67	8·04
9·44	7·03
9·22	13·30
8·71	8·45

positive linear correlation

r=0·895 Sign. 0·01

During a perusal of yield data obtained by D. C. Edwards for different herbage species over a number of years, it at once became apparent that a close connexion existed between yield and rainfall. Using yield data for two different grasses cut at monthly intervals over a period of three years, it was found that a yield of herbage produced in any one month could be positively correlated (sign 0.001) with the total rainfall of the previous month. This knowledge was applied to data obtained from the experiments under review and in respect of newly sown leys, their dependence on an adequate moisture supply may be inferred from the positive correlation which has been established between yields of fresh herbage (expressed in tons per acre) obtained from every level of added nitrogen, and the rainfall in the month prior to cutting. Table XX is produced in illustration.

TABLE XX (L)

Rainfall (in month prior to cutting)	Added N—lb. N per acre			
	0	30	60	120
5·06	6·02	7·24	7·84	7·41
4·79	5·90	7·14	7·65	9·59
4·71	2·74	4·06	6·04	6·53
3·74	3·76	4·47	5·18	6·35
3·63	3·98	6·04	6·72	6·86
3·18	5·60	6·32	5·41	4·56
3·15	3·60	4·23	5·09	5·07
2·45	2·16	3·87	4·54	5·35
2·43	1·98	1·92	2·08	1·01
1·63	1·82	1·81	1·67	1·15
1·41	1·34	2·24	2·15	1·96

Added N—lb. N per acre	r	Sign.
0	0·763	0·01
30	0·805	0·01
60	0·919	0·001
120	0·877	0·001

No such correlation, or indeed any correlation, has been demonstrated in respect of permanent pastures, probably because unlike newly sown leys, the soils of permanent pastures have developed a more favourable soil-water regime by virtue of their surface cover above ground and a well-developed rooting system below.

The efficiency of a phosphatic fertilizer in herbage production also has been found not to be entirely independent of rainfall, as the following tables show; responses over the control are expressed in tons of fresh herbage per acre: —

TABLE XXI (L)

Rainfall in the month prior to cutting	Added P *lb. P_2O_5 per acre*	
	36–0	72–0
5·06	4·17	6·31
4·79	5·75	6·07
4·71	3·61	6·08
3·91	2·12	4·21
3·74	3·26	4·90
3·63	3·28	4·56
3·18	3·41	4·70
3·15	4·42	6·17
2·45	2·41	5·09
2·43	0·73	1·77
1·63	1·09	1·45
1·41	0·56	1·36

positive linear correlation

r=0·798 Sign. 0·01 | r=0·832 Sign. 0·001

TABLE XXII (P)

Rainfall in the month prior to cutting	Added P *lb. P_2O_5 per acre*	
	36–0	72–0
6·50	1·13	1·71
4·48	1·36	1·57
3·52	1·37	0·95
2·89	0·07	0·64
2·28	0·77	1·29
1·92	0·18	0·18
1·87	−0·01	0·01

positive linear correlations

r=0·687 Sign. 0·10 | r=0·805 Sign. 0·02

It will be seen that the higher degree of significance in both forms of grassland is associated with the higher level of phosphate applied, and that permanent grassland would appear less dependent on rainfall than newly established leys. It may be here, too, suggested in partial explanation, that in the circumstances of a more favourable soil-moisture regime associated with permanent grassland, the phosphoric acid concentration in the soil solution may remain more constant.

Further illustrations of the influences of rainfall which have been noted are recorded below:—

TABLE XXIII

Rainfall	Days	Grass	Correlation	Significance
Total from 1 Jan. ..	From 1 Jan to 1st Cut	L.P.	Linear	0·01
Between 1st and 2nd Cut	Between 1st and 2nd Cut	L.P.	,,	0·001
Between 2nd and 3rd Cuts	Between 2nd and 3rd Cuts..	L.P.	,,	0·01
From date of fertilizer application	To date of 1st Cut ..	L	,,	0·01
,,	,,	P	,,	0·02

It is apparent that certain anomalies have been encountered in the behaviour of N and P on newly sown leys and permanent pastures and it seems improbable that they can be explained adequately without an examination of the following factors:—

1. The individual tolerances of specific components of a sward and their capacity to take up plant nutrients.
2. The proportion of available cations and anions in a soil relative to their total concentration: the effect of previous cropping and current fertilizer practice on such concentrations: the possibilities of ionic antagonism between available nutrients under conditions of slight to moderate soil acidity.
3. The base-holding capacity of a soil and the nature of its clay.

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ANNUAL REPORT OF THE PASTURE RESEARCH OFFICER, SCOTT AGRICULTURAL LABORATORIES, NAIROBI, 1951

Grass and Legume Nursery

In 1951, 18 grasses and five legumes were added to the existing collection which now amounts to 150 species and ecotypes of Kenya indigenous grasses and 50 species of legumes. General observations on biology and habit of all the grasses and legumes and more detailed observations on the species and forms which showed promise for introduction into cultivation were continued in 1951. To the promising species already mentioned in previous reports *Cenchrus setigerus* was added as a grass which may be suitable for cultivation in arid areas of East Africa. Some of the promising species were planted in larger plots for detailed study and for seed bulking.

Study of the Types of Pastures in Nairobi Area

An ecological survey on a small scale has been undertaken on the plains east of Nairobi. The plains form a part of a large area known as the Athi and Kapiti Plains. The area under survey covers about 25 square miles at an altitude of approximately 5,000 ft. above sea-level. The main part of the area consists of plains covered with soil locally known as "black cotton soil". The top part of the soil is black clay 2–3 ft. deep underlayed by rock rich in lime. The plains are subject of seasonal waterlogging, and are covered with grassland in which scattered *Acacia drepanolobium* (Whistling Thorn) 4–7 ft. in height is nearly always present. The composition of the grass sward is very characteristic and consists of species mostly confined to plains with black, heavy soil. The plains are occasionally intercepted with valleys. The valleys and the adjacent slopes have quite distinct soil and vegetation.

The following main types of grassland have so far been distinguished in the area under survey:—

1. *Grassland in which Setaria phleoides, Ischæmum brachyatherum, Pennisetum mezianum (Bamboo Grass) and Themeda triandra (Red Oat Grass) predominate in almost equal proportion*

Whistling thorn is nearly always present. The soil is particularly heavy and comparatively deep. The grass cover is dense and tall. However, the main grasses, with the exception of Red Oat grass, are of low palatability.

2. *Grassland with the dominance of Themeda Triandra*

The soil under this type is less heavy and more shallow. In places with particularly shallow soil Whistling thorn is rarely to be found. This type provides very good grazing. Transitional forms between this and the previous type have been often observed.

3. *Grassland with the dominance of Panicum coloratum on alluvial soil in broad valleys*

This type produces fairly good grazing, but its distribution in the area is very limited.

4. *Grassland with the dominance of Cymbopogon pospischilii and with scattered bush on reddish, shallow soil underlayed with murram or rock*

This type occurs on slopes or well-drained flat land adjacent to valleys. The dominant grass (*Cymbopogon pospischilii*) is of low palatability and the grazing is based mainly upon less abundant but more valuable species of *Digitaria, Eragrostis, Hyparrhenia*, etc.

The plains, including the area under survey, are used mainly for grazing: of dairy cattle nearer to Nairobi and beef cattle in more remote places. A comparatively large proportion of the land is under sisal plantations. For supporting cattle in dry periods a certain amount of maize is cultivated for silage. Low rainfall (18–25 in.) does not allow of growing the maize for grain as it ripens only in exceptionally favourable years. Some farmers are experimenting with cultivation of Perennial Kavirondo Sorghum which has shown good results on black, heavy soil. However, like maize, it can not withstand excessive waterlogging and grows unevenly, producing much better stands in slightly elevated places.

Small observational plots with some grazing perennial grasses and legumes were planted at a farm east of Nairobi on plains with black, heavy soil. So far, Rhodes grass and a local perennial legume (*Clitoria ternatea*) have shown encouraging results.

The survey is still in progress.

Soysambu Grazing Experiments

Early in 1947 a mass invasion of an annual grass, *Aristida keniensis* (which is a local species, closely allied to the widely spread *A. adscensionis*), was observed in Star grass pastures on plains sloping to Lake Elmenteita in the Rift Valley. As it was feared that the invasion could be of lasting or even of a permanent nature, experiments were organized with a view to discovering the factors affecting the growth of *Aristida* and to find suitable grassland managements for suppressing *Aristida* and for restoring more valuable Star grass. Experiments which included grazing at various intensities and at different seasons, mowing, burning and complete protection were commenced in July, 1947, and completed in 1951. A short interim report of the experiments was included in the Annual Report of the Pasture Research Officer, Scott Agricultural Laboratories, for 1950.

In 1949 the proportion of *Aristida* in grass-herbage of the pastures near Elmenteita, as well as in the experimental plots, began to decrease rapidly, and in 1950 the amount of *Aristida* dropped to an average of under 10 per cent of the total grass-herbage, a more or less normal proportion of *Aristida* in local Star grass pastures, showing that the invasion was only of a temporary nature. In 1951 the proportion of *Aristida* began to increase again. It is believed that fluctuations in the proportion of *Aristida* in Star grass pastures is connected with variations in the amount of rainfall in a series of years.

Although the proportion of *Aristida* in the grass cover considerably decreased from 1947 to 1950–51 in nearly all plots of the experiment, the rate of eliminating *Aristida* and the amount of it still existing in 1951 were different in plots under various treatments.

It was observed that burning and mowing resulted in a rapid decrease of *Aristida*, although in some of the burnt plots the proportion of this grass increased considerably again in 1951.

The grazing treatments included—

(*a*) permanent grazing of cattle at a rate normally used in the area;

(*b*) permanent grazing of sheep;

(*c*) seasonal grazing (cattle), i.e. grazing at the same period every year in a given plot. The seasonal grazing was applied in two variants: light grazing at a rate of 15 acres per head per year, and heavy grazing at a rate of three acres per head per year. The last density of cattle grazing was actually slightly lower because of the lack of grass for the proposed rate of grazing.

Permanent grazing of both cattle and sheep, although inferior in some other respects, resulted in steady and comparatively rapid decrease of *Aristida*.

Heavy grazing at the end of the growing season (July–September and September–November) showed the best results of all grazing treatments by suppressing *Aristida* rapidly and effectively. Heavy grazing in the dry season November–February) resulted in slow and incomplete elimination of *Aristida*. Grazing early in the growing period (March–May and May–July) produced moderately good results suppressing the undesirable grass slowly but effectively. The results of heavy grazing during the period of March–July were, however, not very reliable because of very poor growth of all grasses at the time of recording. In general, in the plots of light grazing *Aristida* was decreasing slower and with not as good final results as in plots of heavy grazing. Like heavy grazing, light grazing produced much poorer results when applied during the dry period.

Although the design of the experiment and the methods of recording were intended chiefly for studying changes in Star grass: *Aristida* ratio, some useful general information concerning the response of Star grass pastures to various treatments applied in the experiment was also obtained.

The experiments showed that permanent grazing produced grass inferior to that resulting from seasonal grazing. Although in the plots of permanent grazing the proportion of *Aristida* conspicuously decreased towards the end of the experiment, it was replaced mostly by unpalatable annual herbs and not by Star grass.

Heavy grazing resulted in a more even and generally better stand of Star grass than light grazing.

During the experiment the grass in the plots grazed heavily early in the growing season was severely punished and did not recover well after each grazing. It was feared, therefore, that grazing at a rate of three to four acres per beast would destroy the existing perennial grass. However, a rest during the wet season given to all plots after the experiment had been completed and the treatments discontinued restored the grass in a few months' time. After the rest the grass in plots which had been heavily and repeatedly grazed early in the growing period was better than the grass from under light seasonal grazing although inferior to that which resulted from heavy grazing at the end of the growing period.

Repeated mowing, which rapidly eliminated *Aristida*, eventually produced weak grass-cover and undesirable annual herbs began to encroach in masses in 1951.

More details obtained during the experiment will be included in a full report which is in preparation.

Publications

A. V. Bogdan. "A List of Kenya Grasses (with Keys for Identification)." Government Printer, Nairobi, 1951.

D. C. Edwards and A. V. Bogdan. "Important Grassland Plants of Kenya." Pitman & Sons, London/Nairobi, 1951.

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Pasture Research Officer.

ANNUAL REPORT OF THE PASTURE RESEARCH OFFICER, OL JORO OROK, 1951

Introduction

Particular attention has been directed during the year to the following aspects of grassland improvement at Ol Joro Orok:—

(1) Seasonal productivity studies of various grasses.

(2) Lucerne leys—pilot plot.

(3) Establishment studies.

(4) Undersowing trials with wheat.

(5) Seed production from Kentucky 31 fescue.

Meteorological Data

1951 proved to be an abnormal year with respect to rainfall. The yearly average of 35.0 in. was exceeded by 21.8 in. and was notable for the particularly heavy precipitation experienced in April, namely 14.45 in. The monthly figures are appended below. The results obtained during the year must therefore be assessed with considerable reservation. For this reason rainfall figures are included for 1950 which was a more representative year with a total rainfall of 33.08 in. showing the typical failure of the so-called "short rains" when a total rainfall of 2.97 in. was recorded for the quarter October–December, 1950.

Incidence of frost was severe during the early part of the year and in June and afforded the opportunity to observe the effect on tropical grasses and legumes in the trial plots. Guinea grass, *Cenchrus ciliaris,* Naivasha star grass, *Dolichos* sp. *ex* Kilima Kiu and local pigeon pea when well established suffered no serious damage from frost.

TABLE I—RAINFALL OBSERVATIONS AT OL JORO OROK EXPERIMENTAL STATION FOR THE YEARS 1951 AND 1950

	1951		1950	
January	0·15	1 day	0·90	6 days
February	0·14	3 days	0·06	1 day
March	4·01	13 days	1·04	11 days
April	14·45	24 days	5·52	15 days
May..	6·12	12 days	2·28	8 days
June..	2·39	10 days	2·56	14 days
July	4·72	19 days	7·65	23 days
August	6·23	18 days	6·64	23 days
September	2·01	6 days	3·46	10 days
October	4·67	15 days	1·40	4 days
November	3·84	22 days	1·03	11 days
December	8·08	21 days	0·54	3 days

Total for the year 1951—56·81 in.

Total for the year 1950—33·08 in.

Soil Analysis

The following analysis by the Soil Chemist was made on samples collected from the experimental area devoted to pasture work:—

	0–4 in.	4–6 in.	6–24 in.	Below 24 in.
Loss on ignition, per cent ..	16·0	—	—	—
Organic carbon, per cent ..	3·00	1·55	0·78	—
Organic matter, per cent ..	6·87	3·55	1·79	—
Nitrogen, per cent	0·32	0·32	—	—
Exchangeable CaO, ME, per cent	10·2	7·3	—	—
Exchangeable, MgO, ME, per cent	5·4	5·7	—	—
Exchangeable, K_2O, ME, per cent	0·41	—	—	—
pH	5·5	5·5	5·7	5·5

All samples markedly deficient in phosphates.

Grass Productivity under a System of Three-monthly Cutting

Table II gives the total yield for 12 months during 1951 of 17 grasses which were established in 1950. During 1950, cuts were taken and the figures below represent the four cuts taken in 1951. A basal dressing of 100 lb. of single supers and 100 lb. of sulphate of ammonia was applied after planting as the area concerned had been under cultivation for approximately ten years prior to the planting of this trial.

TABLE II

	10th Jan.	10th Apr.	10th July	10th Oct.	Total
	tons	*tons*	*tons*	*tons*	
Brachiaria brizantha ..	—	0·97	10·45	7·05	18·47
Bromus marginatus ..	—	0·77	10·1	12·9	23·36
Cenchrus ciliaris ..	4·57	3·40	16·45	11·95	36·37
Chloris gayana (*Nzoia*)	—	0·12	12·52	10·69	23·33
Chloris gayana (*Uruguay*)	0·77	0·69	14·18	12·39	28·03
Cynodon plectostachyum	0·45	2·27	9·19	5·79	17·70
Cynodon dactylon ..	1·3	4·01	11·58	5·35	22·32
*Dactylis glomerata S*143	—	1·01	2·39	4·58	7·98
Dactylis glomerata Aust.	0·16	0·69	5·14	2·12	8·11
Digitaria smutsii ..	0·25	0·80	3·43	8·47	12·95
*K*31 *fescue*	0·24	0·32	9·60	8·79	18·95
Pennisetum clandestinum	0·32	3·52	15·47	13·86	33·17
P. schimperi	0·32	1·09	5·95	5·63	12·99
Panicum aff. coloratum	0·41	0·97	5·67	7·78	14·83
P. maximum (Rumuruti)	2·26	2·97	19·47	10·42	35·12
Spolobolus filipes ..	1·89	1·44	13·74	10·49	27·56
Themenda trianda ..	—	1·05	3·48	2·92	7·45
TOTAL	13·02	26·09	168·81	140·77	
PERCENTAGE ..	3·7	7·5	48·4	40·4	

Comments

The following grasses are worthy of further trial as possible ley components:—

Brachiaria brizantha.—An aggressive grass which sets seed rather shyly but is spreading in the Thomson's Falls area. The strain used in this experiment was obtained from Njoro but a local *B. brizantha*—Thomson's Falls strain, is now being multiplied and shows more vigour under our conditions.

Cenchrus ciliaris.—A most promising grass for ley work. Seed is set freely and frost had little effect on the foliage. This grass with an annual yield exceeding 36 tons green matter has a good carrying capacity under grazing when employed with a legume such as lucerne.

Star Grass—Cynodon dactylon—Local.—A very promising grass for ley establishment in association with lucerne and perhaps serradella using oats as a nurse crop at 8–10 lb. per acre. Strain selection is essential to obtain a leafy, palatable type. The yield of this grass will be increased considerably by deep cultivation using the sub-soiler. It may be planted from roots using a spacing of 6 ft. x 6 ft.

Star Grass—Cynodon plectostachyum—Naivasha Star Grass.—A very promising grass for leys. Strain work is required to select vigorous, leafy, palatable types which will persist under conditions above 7,000 ft. Selection with this species promises to give types of Naivasha star grass suitable for intensive grazing in the 7,000 ft. to 8,000 ft. region.

Cocksfoot—Dactylis glomerata.—A useful grass for intensive grassland development above 7,000 ft. The best results are likely to be obtained in areas where the annual rainfall exceeds 40–45 in.

Kentucky 31 Fescue.—A promising grass which will respond to row-planted conditions at spacings exceeding 18 in. The present trial was conducted on a spacing of 18 in. which is rather narrow for this vigorous deep-rooted grass. Kentucky fescue is frost resistant and its high fibre content enables it to act as an anti-bloat grass. It should be planted with a legume such as lucerne to enable a satisfactory protein and mineral content to be obtained.

Guinea Grass—Panicum maximum—Rumuruti Strain.—A most promising grass for ley establishment. It is deep-rooted, aggressive, leafy, grows excellently during the dry season and is very palatable. Provided a satisfactory source of seed can be obtained this grass should take a high place in ley establishment in conjunction with lucerne or *Glycine javanica.*

Seasonal Productivity

The percentage figures for the quarterly totals given at the foot of Table II emphasize the great fluctuations which occur in yield during the year. Because of this uneven production it is essential to introduce legumes with grasses as a means of smoothing out production and to preserve a portion of the heavy growth following the long rains as hay or silage or both. Serradella and lucerne are two legumes which thrive in the dry season under satisfactory management and deserve widespread trial alone and as ley components. Serradella in addition shows great promise undersown to wheat provided the seeding rate of the cereal is not too heavy.

Lucerne Leys

Objective.—To compare the following three lucerne leys under row-spaced conditions using two different row widths, with and without subsoiling.

Layout.—Randomized block.

Replication.—In duplicate.

Main Treatments

(1) Kentucky 31 fescue plus lucerne.

(2) Cocksfoot Akaroa plus lucerne.

(3) *Phalaris tuberosa* plus lucerne.

Sub-treatments

(*a*) *Two-ft. spacing between rows*

Kentucky 31 fescue at 1 lb./acre—lucerne at 4¾ lb./acre.
Cocksfoot at 3 lb./acre—lucerne at 4¾ lb./acre.
Phalaris tuberosa at 1½ lb./acre—lucerne at 4¾ lb./acre.

(*b*) *Three-ft. spacing between rows*

K31 fescue at 10 oz./acre—lucerne at 3 lb./acre.
Cocksfoot at 2 lb./acre—lucerne at 3 lb./acre.
Phalaris tuberosa at 1 lb./acre—lucerne at 3 lb./acre.

Date planted.—9th May, 1951.

First grazing: 4th to 8th September, 1951.
Second grazing: 31st October to 2nd November, 1951.
Third grazing: 14th and 15th December, 1951.
Fourth grazing: 14th and 15th January, 1952.

Fertilizer Application

Soda phosphate drilled at 1 in. deep row-placement on one side of row only at 100 lb./acre after establishment.

Table III shows the mean green and dry weights of grass and lucerne separately at each spacing in the non-subsoiled and subsoiled areas respectively for each grazing period and the total yields for the period ended 15th January, 1952.

Comments

1. The excellent production from lucerne in combination with each of the grasses used in this experiment and at each spacing is noteworthy. The mean yield for all treatments was 5.56 tons per acre green which for the period 9th May, 1951, when planted, until 15th January, 1952, is good.

2. Recovery from grazing of the grasses and lucerne was satisfactory.

3. *Phalaris tuberosa* has given the highest yield of the grasses.

4. Cocksfoot will probably give a much higher yield under higher rainfall conditions at higher elevations than Ol Joro Orok.

5. Kentucky fescue is a grass which develops slowly and higher yields may be expected in the second and third years.

6. During the first year the 2-ft. spacing has outyielded the 3-ft. spacing.

7. Subsoiling has shown a tendency to give higher yields with cocksfoot and Kentucky fescue and throughout with lucerne with one exception. It is too early to make a definite statement on this treatment effect but further work should be carried out using a larger plot to assess its value.

Establishment Studies for Leys

Three main methods have been tested for ley establishment: —

(1) Direct seeding in rows using a companion legume.

(2) Broadcast seeding.

(3) Planting vegetative material of Star grass using a wide spacing followed by broadcast seeding on drilling of a legume mixture with a nurse crop of oats.

Row Planting

This method is useful where seed is scarce, weed population high, soil moisture limiting during the dry season and the area concerned reasonably flat. Under good soil conditions row planting may be carried out on sloping land provided all drilling is effected on the contour. Where the land is suffering from soil erosion row planting should not be attempted.

TABLE III—EQUIVALENT YIELD IN TONS PER ACRE AT EACH GRAZING

		1st Gr. 1 Sep.	2nd Gr. 30 Oct.	3rd Gr. 14 Dec.	4th Gr. 15 Jan.	Total
COCKSFOOT AND LUCERNE—						
2 ft. *Not Subsoiled*						
Cocksfoot	Green ..	0·38	1·19	1·38	1·17	4·11
	Dry ..	0·11	0·28	0·28	0·43	1·10
Lucerne	Green ..	0·54	1·44	1·40	0·87	4·25
	Dry ..	0·14	0·35	0·31	0·23	1·03
Subsoiled						
Cocksfoot	Green ..	0·99	2·06	1·89	0·85	5·79
	Dry ..	0·24	0·55	0·34	0·28	1·41
Lucerne	Green ..	0·68	1·78	1·82	1·36	5·64
	Dry ..	0·16	0·45	0·43	0·32	1·36
3 ft. *Not Subsoiled*						
Cocksfoot	Green ..	0·22	1·25	1·18	0·65	3·30
	Dry ..	0·06	0·34	0·24	0·25	0·89
Lucerne	Green ..	0·41	1·03	1·36	0·74	3·54
	Dry ..	0·11	0·25	0·39	0·18	0·93
Subsoiled						
Cocksfoot	Green ..	0·38	1·60	1·65	1·13	4·76
	Dry ..	0·10	0·37	0·32	0·35	1·14
Lucerne	Green ..	0·25	1·68	1·50	0·89	4·32
	Dry ..	0·07	0·39	0·32	0·20	0·98
K31 FESCUE AND LUCERNE—						
2 ft. *Not Subsoiled*						
K31 fescue	Green ..	0·29	1·32	1·42	1·16	4·19
	Dry ..	0·07	0·25	0·29	0·33	0·94
Lucerne	Green ..	1·51	2·70	2·00	1·79	8·00
	Dry ..	0·36	0·64	0·41	0·39	1·80
Subsoiled						
Fescue	Green ..	0·67	2·21	0·98	0·65	4·51
	Dry ..	0·16	0·37	0·22	0·32	1·07
Lucerne	Green ..	0·78	1·63	1·79	1·34	5·54
	Dry ..	0·20	0·39	0·41	0·30	1·30
3 ft. *Not Subsoiled*						
Fescue	Green ..	0·20	0·88	0·78	0·67	2·53
	Dry ..	0·05	0·18	0·16	0·23	0·62
Lucerne	Green ..	0·48	1·36	1·25	1·19	4·28
	Dry ..	0·13	0·32	0·28	0·27	1·00
Subsoiled						
Fescue	Green ..	0·64	1·11	0·98	0·66	3·39
	Dry ..	0·09	0·23	0·19	0·17	0·68
Lucerne	Green ..	0·40	1·54	1·83	1·29	5·06
	Dry ..	0·10	0·37	0·38	0·26	1·11
PHALARIS TUBEROSA AND LUCERNE						
2 ft. *Not Subsoiled*						
Phalaris	Green ..	0·45	2·72	2·16	3·04	8·37
	Dry ..	0·10	0·47	0·36	0·76	1·69
Lucerne	Green ..	1·27	1·92	2·37	0·94	6·50
	Dry ..	0·31	0·47	0·49	0·26	1·53
Subsoiled						
Phalaris	Green ..	0·64	2·99	1·79	2·89	8·31
	Dry ..	0·13	0·47	0·31	0·51	1·42
Lucerne	Green ..	1·02	2·44	2·82	1·08	7·36
	Dry ..	0·25	0·57	0·65	0·26	1·73
3 ft. *Not Subsoiled*						
Phalaris	Green ..	0·29	1·86	2·18	2·59	6·92
	Dry ..	0·07	0·32	0·37	0·64	1·40
Lucerne	Green ..	0·88	1·71	1·85	1·17	5·61
	Dry ..	0·21	0·41	0·39	0·22	1·23
Subsoiled						
Phalaris	Green ..	0·17	2·26	2·65	1·71	6·79
	Dry ..	0·04	0·36	0·43	0·39	1·22
Lucerne	Green ..	0·49	2·40	2·35	1·45	6·69
	Dry ..	0·20	0·53	0·48	0·31	1·52

The following grasses have been successfully established under row-planted conditions at Ol Joro Orok from seed. Cocksfoot, Kentucky 31 fescue, *Phalaris tuberosa, Setaria sphacelata, Bromus marginatus,* Australia veldt grass, Guinea grass—*Panicum maximum.* The width of row spacing depends on the grass and the soil moisture content during the dry season, the legume component and the type of implement used for inter-row cultivation. Grasses such as Cocksfoot and the *Setaria* spp. can be drilled in 2-ft. rows quite successfully. The more vigorous grasses such as Kentucky 31 fescue and Guinea grass appear to thrive better with wider rows, 2½ ft. or even 3 ft. Seeding rates are low under row-planted conditions, reference figures given under lucerne leys.

Broadcast Seeding

Kentucky 31 fescue has been established by broadcasting using a rate of 15 lb. per acre in May, 1950. A basal dressing of 100 lb. single supers and 100 lb. sulphate of ammonia was applied after establishment. On the same day on an adjacent area, K31 fescue was drilled in 3-ft. rows at 10 oz. per acre using a Planet Junior. By far the best results have been obtained from the row-planted material.

Under our conditions where weed competition is very severe immediately after establishment and seed costly, the following points are worth consideration: —

(1) Row planting possesses the advantage of a low seed rate to effect establishment.

(2) Weed invasion is overcome by row cultivation with row planting.

(3) Moisture utilization is much more effective under row-planted conditions.

(4) Yields are much higher from row-planted material on dirty land when row cultivation is practised.

Vegetative Propagation

With grasses such as Naivasha star grass where strains have been selected which enable planting of roots at a spacing of at least 20 ft. by 20 ft (feet, not inches) there is a very strong case for this type of ley planting. Through the courtesy of Gilbert Colvile, Esq., a strain of Star grass "Ndabibi strain", has been successfully established and grazed during 1951 at Ol Joro Orok using a wide spacing of 18 ft. by 18 ft.

This type of planting enables the grass to establish with the early rains and the area kept free of weeds by use of the disc. At the beginning of the long rains serradella alone at 3–5 lb. per acre may be drilled or broadcast with a nurse crop of a grazing oats at 8–10 lb. per acre, or a mixture of serradella 2 lb., lucerne 2 lb. and oats 8–10 lb. can be used. Emphasis is placed on the need for inoculation of all seed of lucerne or serradella before planting. The Senior Plant Pathologist, Scott Agricultural Laboratories, has developed two effective strains of rhizobia for Kenya conditions; strain No. 4 S.A.L. for lucerne (*ex* Marula) and strain No. 19 S.A.L. for serradella. Cultures of these strains can be obtained free of charge from the Senior Plant Pathologist and application should be made at least two weeks before planting stating the amount of seed it is required to treat.

Undersowing Wheat Pilot Trial

Object.—To obtain information on the possibility of undersowing the following grasses and legumes to wheat in the Ol Joro Orok district.

Treatments

(1) Serradella—at approximately 5 lb. per acre in 28-in. drills on 30th June, 1951.

(2) Madrid Sweet Clover—at approximately 3 lb. per acre in 24-in. drills on 17th July, 1951.

(3) Kentucky 31 fescue at approximately 3 lb. per acre in 24-in. drills on 17th July, 1951.

(4) Molasses grass at 30 lb. per acre broadcast on 17th July, 1951.

(*Note.*—The undersown species were planted at two different dates: (*a*) Before the wheat was drilled; (*b*) three days following the wheat.)

Wheat

Drilled at three different rates: 30 lb., 50 lb. and 70 lb. per acre using two drill widths of each rate.

Date.—1st August, 1951.

Variety.—Sabanero.

Phosphate.—Soda phosphate at 150 lb. per acre.

Rolling

A Cambridge roller was used behind the drill to press back any seedlings of the undersown species which were disturbed and to consolidate the seed bed.

Date harvested.—17th January, 1952.

Yield.—Six and a half bags per acre.

It was noticed that the wheat in the 70 lb. and 50 lb. per acre plots had a proportion lying down, whereas the 30 lb. per acre area was standing well. There appeared to be little difference in the wheat yield per acre from the various rates of seeding or the undersown species.

Results

The most promising results were obtained from the serradella. The growth of the undersown serradella was vigorous and appeared strongest in the 30 lb. per acre plots.

Molasses grass grew well under the different seedings of wheat but it suffered from frost damage and the rate per acre was too high to be economical.

The results from the sweet clover and Kentucky 31 fescue were poor but further trials should be conducted especially with the grass. Unfortunately the fescue seed was contaminated with rye grass and this tended to mask the results.

Conclusion

The promise shown by serradella undersown to wheat and the vital need to increase soil fertility under Kenya conditions underlines the urgency for carrying out widespread trials on farms in 1952 with serradella undersown to cereals.

Acknowledgments

Numerous field trials were established on farms during the year and I desire to thank the large number of farmers associated with this work for their assistance and excellent co-operation.

I wish to thank the following officers of the department for advice and assistance with pasture research investigations during the year: Dr. C. C. Webster, Dr. R. M. Nattrass, Messrs. E. Bellis, A. V. Bogdan, G. S. Cowley, H. W. Dougall, D. C. Edwards, G. Gamble, J. T. Moon, J. T. T. Schouten, A. Storrar, and H. C. Thorpe.

Advice on statistical layout of experiments given by Mr. P. Robinson of the East African Agriculture and Forestry Organization is gratefully acknowledged.

The ready co-operation of Mr. D. D. Nicholson throughout the year with experimental work is recorded with thanks.

The valuable help given by the African staff at this station both in the office and the field is gratefully acknowledged.

J. L. SCHOFIELD.

ANNUAL REPORT OF THE PASTURE RESEARCH OFFICER, KITALE, 1951

Meteorological

Rainfall during the season, recorded on the Grassland Research Station, was as follows:—

Month	1951	1950
	inches	*inches*
January	0·82	0·04
February	0·46	0·15
March	3·42	2·47
April	8·48	4·97
May	5·12	2·11
June	3·90	6·39
July	5·86	10·84
August	4·98	3·84
September	2·28	5·10
October	4·78	3·72
November	5·23	0·08
December	4·43	0·37
Total	49·66	40·08

The long season was favourable for the establishment and growth of grass plots, but had an adverse effect on seed production. Harvesting was difficult and fungous diseases prevalent.

Summary of Work

The work carried out during the season falls into the following groups:—

(1) Trials on Grassland Research Station.

(2) Experiments on Grassland Research Station.

(3) Trials outside the Grassland Research Station (Co-operative).

(4) Experiments outside the Grassland Research Station (Co-operative).

A distinction is made between "trials" and "experiments" in that while an experiment is fully replicated and designed statistically, a trial is not.

1. The following is a summary of trials in progress on the Grassland Research Station during 1951.

(*a*) *Nursery Observation and Preliminary Trials*

Two nurseries were started, legumes in one and grasses in the other.

The purpose of these is for preliminary observation of all plants and seeds collected locally, or obtained elsewhere.

Approximately 170 different grasses and 180 different legumes were planted out.

Growth records have been kept for each plot.

Seed is being collected from each of these, and the most promising will be bulked in seed multiplication plots.

(*b*) *The Establishment* (*Using a Maize Planter*) *of Melinis minutiflora under Maize*

The main object of this trial was to study the possibility of establishing Molasses grass under maize, using a maize planter and planting with the maize. Plots were sown with and without legumes.

By the end of the season, the grass planted at the same time and in the same lines as the maize, had made excellent growth.

A record is being kept of yields of maize with and without the grass undersown, in order to give some idea of the effect of this method of undersowing on maize yield.

(*c*) *The Establishment* (*Using a Maize Planter*) *of Chloris gayana under Maize*

Details of this are essentially the same as for the Molasses grass trial ((*b*) above). Excellent growth was made by the grass.

An estimation of the effect of establishing grass by this means will be possible after another season.

(*d*) *The Establishment* (*Using a Combine Corn Drill*) *of Molasses grass, plus Legumes, Under Oats*

This trial was partially successful and was ploughed in before the end of the year. It is to be repeated, with modifications, in 1952. The grass and legume seed was mixed with fertilizer and drilled through the fertilizer attachment, while the oats were drilled as usual through the seed box.

The principle of establishing a ley under a cereal by this method appears to be sound, but the technique must be improved.

(*e*) *Preliminary Ensilage Trials Using Various Mixtures of Fodder Grasses and Legumes*

The object was to observe some single-plot grass/legume mixtures and to try making ensilage in miniature silos which might be used for future trials and experiments.

The following mixtures were tried, grasses and legumes being sown in alternate lines:—

(1) *Panicum maximum* var. *trichoglume* plus lucerne.

(2) *Beckera* sp. plus *Dolichos lablab.*

(3) *Panicum maximum* var. *trichoglume* plus *Dolichos lablab.*

(4) *Beckeropsis* sp. plus lucerne.

(5) *Dolichos lablab* alone.

Of these, the mixture of *Panicum* and *Dolichos* is showing promise, having given two cuts. The *Dolichos* alone gave three cuts during the season. Yield figures are not given as, from single plots, these may be misleading.

Experience gained from this trial indicates that row spacing should not be wider than 18 in. for special silage mixtures of this type. Furthermore, the advantage of sowing the grass and legume down separate lines is doubtful.

Material cut from these plots was ensiled in 44-gallon drums. The temperatures never rose above 76° F. It is probable, therefore, that such containers are too small for this purpose.

2. The following is a summary of experiments in progress on the Grassland Research Station during 1951:—

(*a*) *The Evaluation of Species by Seasonal Yields of Herbage and Nutrients*

The following 16 grasses were planted out in plots 4 yds. by 3 yds. using four replicates in a randomized block design:—

Cynodon dactylon (fine-leaved type).
Panicum maximum var. *trichoglume.*
Panicum maximum (Kitale type).
Cenchrus ciliaris (low-growing strain).
Cynodon dactylon (coarse type).
Themeda triandra.
Brachiaria brizantha.
Setaria sp. *ex* Nandi Reserve.
Hyparrhenia filipendula.
Brachiaria soluta.
Melinis minutiflora (*ex* Chania River).
Paspalum dilatatum.
Setaria trinervia.
Chloris gayana (Nzoia Strain).
Panicum coloratum var. *makarikariensis.*
Melinis minutiflora (commercial).

No cuts were made during 1951 as it was necessary to allow the season's growth on plots to become fully established. Cuts will start in 1952.

(*b*) *The Establishment of Temporary Leys*

The following are being compared:—

Three methods of establishment, viz.:—

1. Direct seeding or planting.
2. Seeding or planting under oats. The oats were subsequently grazed.
3. Seeding or planting under maize.

Two grasses:—

1. Molasses grass.
2. Star grass (*Cynodon dactylon*).

Two fertilizer treatments:—

1. Nil.
2. Sixty lb. per acre of P_2O_5 plus 100 lb. N per acre, broadcast after growth of the grass had started.

Each treatment was replicated four times.

(*c*) *An Experiment Designed to Measure the Residual effect of Fertilizers Applied to Grassland*

This experiment was carried out on Molasses grass in its third season after establishment.

Results from this are not yet to hand.

(*d*) *The Fertilizing of Natural (Veldt) Grassland*

Results indicate little response to fertilizers (ammonium sulphate and single superphosphate) on grassland of this type.

(*e*) *The effect of Fertilizers on Establishment and Subsequent Growth of Alysicarpus glumaceus*

First results show a poor response to the fertilizers (ammonium sulphate and single superphosphate).

(*f*) *The Fertilizing of Established Molasses Grass for Seed Production*

This is a factorial experiment using 1/40th-acre plots. The effect of nitrogen and phosphate only is being tested on seed production.

3. The following is a summary of trials started outside the Grassland Research Station (co-operative) during 1951.

(*a*) *The Control of Thorn Bush (Acacia spp.) by Chemical Means*

The following are being compared:—

1. Two substances, 2, 4—D and 2, 4—D/2, 4, 5—T.
2. Two concentrations of each mixture, for painting on tree trunks and cut stumps; and two concentrations of each for spraying the foliage and suckers.
3. Two carriers, diesel oil *v.* water.
4. Three placements: basal girdling *v.* cut stumps *v.* suckers.

4. The following is a summary of experiments conducted outside the Grassland Research Station (co-operative) in 1951. The experiments were in two groups:—

Type A—to study the influence of fertilizers in the establishment of temporary leys.

Type B—to study the effect of fertilizers in increasing the production of established leys and permanent grassland.

(*a*) Sixteen *Type A* experiments were laid down on farms in Trans Nzoia and Uasin Gishu Districts.

Of these, 13 yielded data and 3 failed.

The following treatments were applied in the seed bed in these experiments:—

2 cwt. single superphosphate per acre.
4 cwt. single superphosphate per acre.
8 cwt. single superphosphate per acre.
1½ cwt. ammonium sulphate per acre.
3 cwt. ammonium sulphate per acre.
6 cwt. ammonium sulphate per acre.

(*b*) Seventeen *Type B* experiments were laid down on farms in Uasin Gishu and Trans Nzoia Districts. Thirteen of these yielded data and four failed.

The following treatments were applied:—

50 lb. of N per acre.
100 lb. of N per acre.
200 lb. of N per acre.
300 lb. of N per acre.
400 lb. of N per acre.
200 lb. single superphosphate per acre.
400 lb. single superphosphate per acre.

The P was applied in one dressing at the start of the experiment while the N was applied in three equal dressings; once at the start, and after each of the second and third cuts.

Conclusion

As a result of a visit by Dr. William Davies in October, it was decided that the main Grassland Research Station should be centred at Kitale.

More land has therefore been taken in, the area of the station now being about 1,200 acres.

Plans are in hand for large extensions to buildings and living quarters for both Europeans and Africans, and extra staff will be engaged.

The year 1951 has inevitably been one of change and development, but some results should be forthcoming by the end of 1952. There are very promising grasses and legumes under observation in the nurseries, and it is felt that, as the station develops and staff is increased, there is good prospect of fruitful years ahead.

R. STRANGE,
Pasture Research Officer.

ANNUAL REPORT OF THE PASTURE RESEARCH OFFICER, KABETE, 1951

Meteorological Data

Total rainfall, 56.53 in. Long rains, March–July, 36.52 in. Short rains, October–December, 18.48 in. There was no month without rain—the lowest months being February, 0.16 in., and September, 0.1 in. The high rainfall undoubtedly influenced the amount of smut present on grasses, which was very common.

Report on Experimental Work

(1) *Grass Legume Mixture Experiment* (*ref. Annual Report,* 1950)

This statistical experiment, which was laid down in 1948, was finished on 21st May, 1951. Of the six legumes used, i.e. *Trifolium johnstoni,* Lucerne 37S4, *Crotalaria intermedia, Indigofera tettensis, Glycine javanica,* and *Medicago denticulata,* only two have persisted in the Rhodes grass under which they were sown. They are *Glycine javanica* and lucerne, which survived 13 cuts between 17th May, 1948, and 21st May, 1951, all the other legumes having practically died out except the *Trifolium* which, being indigenous, comes into the plots naturally. Whilst there was no significant difference between the total yield of lucerne and *Glycine,* the *Glycine* yielded significantly more than the *Trifolium* (Po.01). The value of *Glycine javanica* and lucerne as ley legumes under Kabete conditions is thus established and they should be tried more extensively. It is not possible to give yields of legume in terms of dry matter per acre owing to the method of sampling and recording used.

(2) *Dolichos sp. ex Kilima Kiu—Feeding Trial*

Dolichos was fed to four in-calf heifers over a period of six weeks from 17th July, 1951, to 31st August, 1951 (during dry weather). The *Dolichos* was fed daily, either by cutting and *boma* feeding or by allowing the animals to graze directly on the legume plot. A ration of Rhodes grass (green) was also fed in the *boma.* The heifers relished the legume after the first day, thrived, and have since all calved down normally. As in 1950 there were no toxic effects of the legume during or after the period of the trial.

(3) *Possible Toxic Effects of Perennial Kavirondo Sorghum*

Periodic analyses were made on the sorghum (sown in March, 1951). At no stage of growth was the concentration of HCN higher than 0.016 per cent. The analyses of wilted material and the aftermath will be continued during 1952.

The analyses were made possible by the co-operation of Mr. Braithwaite of the Veterinary Department.

(4) *Quick Colorimetric Method for Testing Sorghum Plants for HCN*

A method suitable for testing large numbers of plants was tried out with promising results.

(5) *The Ecology of Acacia drepanolobium (Whistling Thorn)*

Work was started and the initial results indicate that the prevalence of whistling thorn on the Nairobi heavy black cotton plains is intimately bound up with the water-table level.

(6) *Plot Sizes for Pasture Work*

Work is proceeding on this basic subject and will, it is hoped, be published early in 1952.

(7) *Subterranean Clover—(Sown April,* 1951)

A small unreplicated trial with three strains of the clover showed that there was no visible difference either above ground or in the number of nodules present between inoculated and uninoculated plants. The trial was done on the pasture plot field and on another field at the top of the Veterinary farm. The fact that the clover on the new field is doing extremely well and is setting seed, whilst that on the pasture plot field has died out, emphasizes the need for further nutritional studies on this potentially valuable clover.

(8) *Setaria sp. ex Nandi—Strains of*

Observations during the past year show that at least three strains are present in this species. Work on selected plants will be continued during 1952.

Normal routine work, i.e. collection of new material, seed collection, and work on experiments which have not yet reached a stage at which a report would be of value are not included in this annual report.

W. R. BIRCH,
Pasture Research Officer.

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (HORTICULTURE), 1951

Meteorological Data

MOLO

MONTH	Rainfall	Sunshine	Temperature Mean monthly
	inches	*hours*	°*F*
January	0·79	233·4	57·0
February	0·67	219·4	57·4
March	5·10	181·5	59·3
April	17·60	54·11	57·8
May	4·80	218·4	56·9
June	2·55	190·0	55·6
July	3·79	184·2	54·2
August	5·55	120·4	54·4
September	1·54	174·7	56·2
October	2·75	183·6	56·3
November	4·29	192·7	56·9
December	11·95	184·7	59·9
TOTAL	61·38	2,137·1	

MONTHLY RAINFALL AT JACARANDA

MONTH	*Inches*
January	0·00
February	0·38
March	4·54
April	17·43
May	5·19
June	6·08
July	0·97
August	1·31
September	0·36
October	3·52
November	5·97
December	9·81
TOTAL	21·94

MONTHLY RAINFALL AT MATUGA

MONTH	*Inches*
January	—
February	0·45
March	3·58
April	5·03
May	15·90
June	1·08
July	4·01
August	1·12
September	0·44
October	8·42
November	7·74
December	3·97
TOTAL	51·74

Experimental Work

SUB-TROPICAL FRUITS

CITRUS

It has been decided to commence work on the propagation of citrus varieties on different rootstocks. The varieties of stocks to be worked on are rough lemon, sweet orange and *Poncirus trifoliata*; the latter may in time, because of its dormant and deciduous nature, prove of especial value under certain of our conditions. The scions to be used will be Valencia late, Washington Navel, grapefruit and lemon. All propagation is to be done at Matuga and later budded trees of each

variety are to be sent to the two sub-stations at Kitale and Jacaranda. A start was made by selecting a well-grown, prolific-bearing rough lemon tree at Sante Irrigation, Ltd., Taveta, and seed of both sweet orange (Palmer) and *trifoliata* was ordered from the Sub-tropical Horticultural Research Station, South Africa. Unfortunately we were unable to obtain the full quantity of seed required for the trials as the supply in South Africa was exhausted when we wrote and only a small parcel of each variety was despatched. The three varieties of seed were duly planted in seed beds and to date the rough lemon has grown exceptionally well. A very poor germination was realized in the imported varieties owing chiefly to a delay of 23 days in transit from South Africa, most of the seed by then having lost its viability. Fresh seed of *Poncirus trifoliata* will again be imported during the coming season but it has been decided to select a good-bearing sweet orange tree locally.

PINEAPPLE

Pineapple Propagation.—In view of the acute shortage of pineapple planting material, steps were taken to investigate new methods in an attempt to accelerate the production of planting material over the more orthodox but slower methods of reproducing by slips, suckers and tops. The material and method used were as follows:—

(*a*) "Discs" produced by cutting up unfruited mature stems.

(*b*) Fruit tops and suckers split into vertical sections.

(*c*) Mature fruit top leaves.

Propagation was first attempted in closed propagating frames and in open outdoor beds. Later, when it was found that outdoor results were as good as, if not better than, the closed frames, frame propagation was abandoned except for leaf cuttings. "Discs" were produced by cutting mature, non-fruiting stems into discs of $\frac{3}{8}$-in. to $\frac{1}{2}$-in. thickness and then embedding them into a sand cushion to a depth of 1 in. Watering was carried out daily during all dry periods. As shoots became established on their own roots they were removed either by making a wedge-shaped cut or by a gentle pull, whichever means best suited the extent of attachment. The shoots were then transplanted to nursery beds.

Ten stems produced 87 "discs" and within 46 days shoots commenced to show. Shoot production, however, was considered very slow and irregular; the last shoots being produced after a lapse of 342 days. In all, 130 shoots were produced and of these 23 died before rooting. The remaining 107 were successfully transplanted in the nursery in three batches. The first batch of 42 shoots was transplanted 165 days after insertion of the discs. At 14 months these had attained a leaf spread of 14 in. The second and third batches were transplanted at 280 and 366 days respectively. Shoot production per stem was 10.7.

Fruit tops were cut into small vertical sections ranging from 8 to 26 sections per top. The sections were made by cutting upwards through the basal tissue of the top and the sections were then dibbled into the nursery bed. Several different trials with fruit-top segments were planted to determine—

(*a*) whether sections of fruit tops could be propagated and if so, what size sections would produce best results;

(*b*) the possibilities of establishing sections by planting in the open during the long rains, thereby reducing costs;

(*c*) what effect the drying out of tops would have on shoot production as opposed to fresh tops;

(*d*) the possibilities of rooting sections of suckers as opposed to fruit-top sections;

(*e*) the effect of hormones on fruit-top sections;

(*f*) whether mature fruit-top leaves would propagate.

Observations revealed that 26 and 12 sections per top frequently became exhausted and died before the roots could be produced on the new shoots. The eight sections per top, when established, made good progress. Planting top sections (eight per top) during the long rains was very successful. In 63 days 43 per cent had produced shoots and within 100 days the percentage had risen to 95. The figures given are based on a rainfall of 31.97 in. with rain falling on 59 days out of the 100. Drying out of fruit tops for 21 days prior to cutting up and planting does not appear to have any effect on shoot production. Propagation by top sections is vastly superior to propagation by sucker sections. Moreover, it was not possible to produce more than four sections per sucker as opposed to the optimum eight sections per top. Shoot production of tops showed 90 per cent in 155 days as opposed to 32 per cent by suckers during the same period. Hormone trials did not produce any significant results in the concentrations used. The hormones were B-Indolyl Butyric acid, Seradix B No. 1, and Hormotone A. Leaf cuttings were inserted in closed propagating frames and the results of two trials showed a 5.55 per cent rooting in both cases.

The conclusions to be drawn from these experiments are that the eight sections per fruit top method is far superior to the stem disc method. Maximum shooting production by discs was not reached until 342 days, whereas maximum production by top sections was attained in 93 days. Nothing appears to be gained by drying out fruit tops prior to cutting up. Top sections numbering eight per top produced far superior results than propagation by sucker sections which cannot be cut up into more than four sections satisfactorily and which tend to produce shoots very much more slowly than top sections. Fruit top sections could be successfully utilized to accelerate the output of pineapple planting material, but the method would require nursery conditions until the young plants are established.

Spacing Trial

Approximately 450 suckers (Smooth Cayenne Variety) were planted in five separate blocks at different spacing. The spacings were as follows:—

No of plants in block	Spacing in row	Spacing between rows	Number of rows
	inches	*inches*	
Block 1. 100 ..	18	24	2
Block 2. 142 ..	12	24	2
Block 3. 150 ..	18	18	3
Block 4. 48 ..	36	36	2
Bloc 5. 111 ..	24	24	3

This trial was started for the sole purpose of determining whether close or wide spacings have any effect on the size and weight of fruit.

Fertilizer Trial

A small fertilization experiment was also started on Smooth Cayenne pineapples on 9th November in six beds spaced 18 in. in row, 30 in. between rows and three rows per bed. Each bed 5 ft. wide was divided into five blocks 14 ft. long with 2½ ft. between blocks. Ammonium sulphate was applied to the blocks at different rates of application, the blocks in each bed received at randomization the rate of 1, 2, 3 and 4 cwt. per acre and one control. It is clearly evident from observation that a high application of ammonium sulphate is beneficial to the growth of pines.

The "Replant" Problem

In the Thika area, where the greater part of the pineapple acreage is concentrated, the biggest problem at present is that of replanting pineapples on land which has already produced one cycle of pineapples and also on land which has previously grown other crops than pineapples. Pineapples planted under these conditions generally show the following symptoms:—

Chlorosis and dwarfing of the whole plant.
Necrosis of the leaf tips.
Fruits produced weigh only a few ounces.
Susceptibility to mealy bug attack.

The most likely causes of these symptoms are: deficiency of one or more major and minor elements necessary for plant growth, and attack of the plant roots by nematodes.

The general practice has been to grow pineapples without any fertilizer. While the acreage was small it was possible to shift the crop on to virgin land at the end of each cycle and thus produce a good crop very cheaply. With the advent of pineapple canning the acreage has expanded rapidly and it is evident that growers will have to fertilize their crops, and in some cases possibly, fumigate the soil against nematodes. Several experiments designed to ascertain the nutrient requirements of pineapples when grown continuously on the same land have been planned. The first of these experiments was started in December on the farm of Mr. C. W. P. Harries at Thika. In this experiment all plots receiving nitrogen in the form of sulphate of ammonia, show a strong favourable reaction. An increase of plant vigour and improvement in leaf colour has also been noted at the Jacaranda and Matuga Horticultural Stations following the application of sulphate of ammonia to chlorotic pineapple plants.

Deciduous Fruits

Apples Affected by Bitter Pit

Nearly all the fruit harvested at Molo in the 1951–52 season was heavily affected by Bitter Pit. Those fruits which did not show symptoms at the time of harvesting nearly all developed marked Bitter Pit during the subsequent storage period. The symptoms of Bitter Pit are dark, sunken spots on the skin of the fruit. The flesh beneath these spots is brown and corky and has a most unsightly appearance.

Bitter Pit is physiological in origin and is not caused by a disease organism. Although by no means unknown in Kenya such heavy damage as is the case with the last crop at Molo is unusual. One of the factors said to cause Bitter Pit is an excess of nitrogen in the soil, it is thought that this is the most probable cause of the trouble in the present instance. The trees at Molo were planted in 1946 or 1947 and have been manured annually with farmyard manure at the rate of one or two *debes* per tree, although this does not appear to be a very heavy dressing, the annual growth made by the trees in many cases is excessive, which does indicate a probable excess of nitrogen. In view of this it was decided not to apply manure to any of the apple trees until annual growth is reduced to a point where it is considered necessary. The effect of this treatment on the incidence of Bitter Pit will be observed.

Growers are warned to be sparing in the use of nitrogenous organic manures or fertilizers on apples, particularly if the average annual shoot growth made by the trees is much in excess of 18 in. in length.

Magnesium Deficiency in Apples and Pears

This year, spraying with magnesium sulphate was started considerably earlier in the season, on 8th December, as far as possible coinciding with the blossom fall stage. Trees were sprayed at fortnightly intervals, some receiving four, and some six applications. Spraying has resulted in most cases, in the almost complete disappearance of symptoms of magnesium deficiency. There was very little difference in the reaction of trees which received six applications compared with those which received only four.

When assessing the results of spraying it is important to study each variety separately. The symptoms of the deficiency, that is chlorosis and necrosis of the leaves, and premature leaf fall, vary very greatly in different varieties. Some varieties show no chlorosis but the leaves are covered with necrotic patches, others show a marked chlorosis with very little necrosis. Others show bronze or red colours in the leaves. Pears show bands of red and yellow colours in the leaves.

The results obtained at Molo justify a recommendation to growers that where symptoms of magnesium deficiency are observed in apples and pears, curative spraying should be carried out. Four applications of a 2 per cent solution of Epsom-salt should be sprayed on at fortnightly intervals, starting at the petal fall stage.

Apple Rootstocks

Apples on Malling XIII, M. 411, M. Immune 10, and M. Immune 12, are continuing to make good growth in the orchard this season, most of the trees are bearing a small crop of fruit.

The rootstock of M. 411, semi-vigorous, is no longer classed as Immune to Woolly Aphis by East Malling Research Station. As Woolly Aphis is not a serious problem in most districts, it could still be a useful stock in Kenya. Apples worked on Malling Crab "C" have made extremely vigorous growth in the nursery.

Prolonged Dormancy

This season the reaction of deciduous fruit trees oil-sprayed against prolonged dormancy has been particularly marked. Mean temperatures for July and August were not higher than normal, the strong reaction to spraying cannot therefore be accounted for on the grounds of high winter temperatures. All sprayed and control trees have now received the same treatment for two years in succession; it is thought that the effect of spraying is cumulative from season to season in that the growth and cropping cycle is regularized.

The yield figures for the three plum varieties Shiro, Beauty and October Purple, is given in the table below, and show how the cropping of these varieties is improved by oil-spraying:—

Tree No.	Variety	Treatment	Crop Seasons 1950/51	Crop Seasons 1951/52
111	Shiro	Dytrol 5%	19 lb.	92 lb.
112	Shiro	Untreated	3½ lb.	4 lb.
272	Beauty	Dytrol 5%	18 lb.	52 lb.
273	Beauty	Dytrol 5%	24 lb.	78 lb.
274	Beauty	Dytrol 5%	20 lb.	61 lb.
275	Beauty	Untreated	Nil	5 fruits
113	Oct. Purple	Dytrol 5%	No figs.	24 lb.
114	Oct. Purple	Dytrol 5%	No figs.	19 lb.
115	Oct. Purple	Dytrol 5%		45 lb.
116	Oct. Purple	Untreated		2 fruits

South African workers have proved that oil sprays containing D.N.O.C. are more effective in breaking dormancy than plain oil emulsions. D.N.O.C. oil sprays have been used at Molo for several seasons but there has been no opportunity to test their effectiveness as compared to plain oil emulsions, in a reliable manner.

Apricots

Apricots at Molo have suffered very severely from a physiological cracking of the fruit. In California this trouble is said to be due to the alternating effects of moisture, caused by dew or mist, and hot sun on the skin of the fruit. The cracking of the fruit is so bad at Molo that apricots are not considered to be an economic proposition. All trees in the experiment orchards, except for one specimen of each variety have now been grubbed out.

Plums

The plums this season carried a very heavy crop. Methley Tazagine and Settler trees on their own roots, at four and a half years from planting, averaged nearly 200 lb. of fruit per tree. One Methley tree on a peach rootstock five and a half years old from planting, carried 320 lb. of fruit.

Almonds

It appears unlikely that almonds will be a commercial success at Molo. The trees are very susceptible to root diseases, and to gummosis; they have borne only very light crops to date.

Armillaria Root Rot

This disease is by far the most serious of those which attack deciduous fruit trees in Kenya. The disease has been present in Block A at Molo since it was planted in 1946, and as a result, a few trees have been killed each year. In 1951, probably owing to the heavy rains, a larger number of trees than usual were killed and many more were discovered to be more or less badly infected. Where a tree has died a trench has been dug round the infected area in order to isolate it as far as possible. In some cases carbon bisulphide has been injected into the soil round dead trees to kill the fungus in the soil; this method is, however, very expensive. Usually the only way in which infection can be discovered before the tree dies is to dig round the base of the trunk and look for the disease on the main roots. Sometimes infected trees can be saved by cutting out diseased areas of roots or trunk and disinfecting the wounds.

In view of the present disease situation in Block A, it is not considered worth while to replant where trees have died, with experimental material. Replanting will be carried out where necessary with bulk material which can be used to study the course of the disease.

Propagation

A trial of chip budding as a method of propagating apples was made by Mr. Back. This method resulted in a "take" of nearly 100 per cent, which was greatly in excess of the "take" resulting from whip and tongue grafts carried out at the same time. Growth from buds was very regular. One advantage of chip budding is that it can be carried out when the bark of the stock is not slipping.

Marketing

Over two tons of plums were marketed this season, chiefly in Nairobi. All the fruit was properly graded and packed, the demand for it far exceeding the supply. Many growers contend that the market for plums is poor; this does not appear to be the case if the fruit is attractively presented.

The formation of the Horticultural Co-operative Union, which is expected to start operations early in 1952, is likely to boost the horticultural industry very considerably by lifting the burden of marketing from the shoulders of the grower, and by increasing consumption of horticultural produce through better distribution. The Co-operative will only succeed, however, if it receives the full support of its members.

Processing

A six-pound sample of dried Keiffer pears was sent to the Colonial Products Advisory Bureau, Imperial Institute, for a market report. The Bureau submitted parts of the sample to a number of firms and to the Ministry of Food. Comments generally were rather unfavourable on the quality of the sample but it was considered that it would find a sale, in the present state of the market. The price offered by the Ministry of Food for dried pears is, however, very low.

The object in producing dried pears is to supply the local market in the first place, but a United Kingdom market report is of great assistance in assessing the quality of the local product. Suggestions on improving the quality of our dried pears were made by the Ministry of Food; these will be tried out.

Small Fruits

Germination of Seed

Trouble has been experienced in germinating the seeds of such fruit as strawberry, blackberry, raspberry and youngberry. Acid and alkali treatments were tried on various *Rubus* spp. without success. The normal method of stratifying the seed in autumn and exposing it to frost throughout the winter, as practised in temperate climates, is not possible in Kenya. The method in use at present, which has proved very successful, is to stratify the seed in pots of sand. The pots are placed in a refrigerator, near the freezer compartment, for six weeks. The sand must be kept moist during this time. Seed treated in this way germinates readily on being sown in soil at ordinary temperatures.

Strawberries

The plot of Melba strawberries which is 1/7th of an acre in area, yielded at the rate of 2,600 lb. per acre over 12 months. The Melba strawberry at Molo bears fruit all the year round, when grown under irrigation. The crop generally reaches a peak period every few weeks, with the crop falling to nil between peaks.

Of the many varieties now under trial at Molo at present only the Cambridge seedlings Nos. 448 and 449 have done sufficiently well to be recommended for trial by growers. These seedlings have made vigorous growth and are cropping well. The fruit is inclined to be small, but it is very firm and should travel well. The flavour is fair. Quite a proportion of the fruits were attacked by mildew, probably owing to the wet season and the microclimate under the heavy growth of leaves. The seedlings are resistant to strawberry leaf spot.

A trial was carried out to find whether Melba strawberries could be transported successfully from Molo to the market in Nairobi. The standard method of packing strawberries for transport was used, i.e. the fruit packed in 1-lb. punnets enclosed in a wooden crate. Fruit picked in the afternoon and transported to Nairobi by car the following morning arrived in excellent condition and found a ready sale. Fruit picked in the morning, railed in the afternoon and arriving in Nairobi the next morning, had started to break down, was unattractive in appearance and not considered saleable.

The trial shows that Melba strawberries must arrive at the market within a few hours of picking. Large-scale growing is not therefore practical, except in the vicinity of the larger towns.

Royal Sovereign x Melba

Only one plant has been raised of this cross. The plant is vigorous and appears to be resistant to strawberry leaf spot. So far the fruit does not appear to be superior to Melba.

Raspberries

Malling Promise and Norfolk Giant.—These two varieties made satisfactory growth of canes, but as with Lloyd George the mature canes do not break dormancy, except for odd buds. Spraying with an emulsion of D.N.O.C., as used for breaking dormancy of deciduous fruits, possibly has some slight effect, but the result cannot be regarded as worth while.

Unknown Variety ex Kinangop

Plants of this variety were received from J. Lane, Esq. The canes seem to be less susceptible to prolonged dormancy than the other varieties tried.

Youngberry

This trailing berry is so far quite the most promising berry fruit for medium and high elevations in Kenya. There is no doubt that the demand for it as a fresh fruit and for canning would be very great. The planting at Molo has been considerably extended. A plot of 40 youngberry plants at Molo, planted in 1947, yielded this season at the rate of 924 lb. per acre. The plant spacing is 5 x 10 ft. As this plot is on rather poor soil the yield could probably be exceeded. The cropping period lasts about two months (January–February).

Vegetables

Trials at Jacaranda

Four trials were planted during the year consisting of a 13-variety tomato trial, a single-tomato variety trial, a three-variety bean trial and a single-variety lettuce trial. Of the four trials the lettuce produced the best results. The almost complete failure of the other trials was mainly attributed to poor soil conditions on unfertilized bench terraces, and insufficient moisture. There appears to be little doubt that bench terraces must be fertilized and irrigated if they are to be used for the cultivation of shallow-rooting crops.

The maximum yield produced in the 13-variety tomato trial was from the variety Riverside which yielded 3,016 lb. per acre. The lowest yield was produced by early Detroit with 541 lb. per acre.

The lettuce trial was composed of the variety Mignonette. Seeds were sown during the long rains on unfertilized bench terraces, sowing to a distance of 2 ft. between rows, later thinning the seedlings within the rows to a distance of 9 in.

Harvesting was completed in six operations, the first being carried out 85 days from the date of sowing. The trial period covered 169 days and the rainfall during the period totalled 34.48 in. with precipitations being recorded on 61 days.

Actual yields showed 6,644 lb. per acre and with a full stand yields of 8,855 lb. could have been produced. Average weight per head was five ounces. One of the largest heads weighed ten ounces and measures 12 in. in diameter.

The low average weight per head was undoubtedly caused by the difference in soil fertility between the front and back half of the terrace.

Trials at Molo

Asparagus

A trial of the variety Mary Washington was planted in August at two different spacings. The plants have made good growth. The plants were damaged by buck during the dry season, the plot has now been electric fenced.

A slight infection of rust has infected some plants but this does not appear to be serious at present.

Onions

Object.—Cropping trial with the variety Texas Grano.
Locality.—Horticultural Station, Molo. Block B.
Altitude.—8,200 ft.
Soil type.—Medium dark loam.
Rainfall during experiment.—31.95 in.
Date of commencement.—14th June, 1951.

The onion seed Texas Grano was received from Messrs. Dalgety & Co., Ltd., Nairobi, who asked us to carry out a cropping trial, sown on 14th June, 1951; the germination was good and transplanting took place during the beginning of August. All through the following months the growth was very promising and the individual plants bulbed extremely well. On 1st March, 1952, harvesting was commenced, picking the completely mature bulbs only. Most of the bulbs were of a good size and an even pink-yellowish colouring. Crop: 1,045 lb. (fresh weight) on a plot size of 224 sq. yd.—roughly ten tons per acre.

This variety bulbs satisfactorily in a short day climate and is recommended for local growing. The crop did not ripen as well as expected, probably owing to the wet season.

Miscellaneous Crops

Broom

Seeds of common and Spanish broom received from "Fibratex" of France for trial as fibre plants were sown at Molo in April. After a poor start the plants of both species have made good growth. At one year after sowing the common broom plants are about 5 ft. high and the Spanish 6 ft.

Olives

Unpublished work carried out at the University of California by Dr. Hartiman indicates that olives will not flower satisfactorily unless subjected to winter chilling.

Good yields are obtained at Sacramento, California; mean January temperatures 45.6° F.

Poor yields are obtained at Riverside, California; mean January temperature, 52° F. Trees are non-fruitful at Brownsville, Texas; mean January temperature, 59° F.

The above figures bear out results obtained in Kenya with the few trees that have been planted in various parts of the country. It would appear not to be worth while to undertake any experimental work on olive-growing in Kenya in view of the fact that winter temperatures are not low enough to induce flowering.

Macadamia Nut

This nut is becoming an important economic crop in Hawaii. Most of the crop is exported to the United States. The demand by far exceeds the supply and the price is high. A few trees growing on private estates at Thika and Mount Elgon are making encouraging growth but are not yet in bearing. A small quantity of seed brought back from Hawaii has been distributed to Jacaranda, Matuga, C. W. P. Harries, Esq., Thika, and E. Rodseth, Esq., Ruiru.

Mangels

During 1950 a test of mangel varieties was carried out. About 10 per cent of the roots showed signs of heart rot when harvested. It was thought that this might be due to a soil deficiency of boron.

The trial described below was designed to find out whether the heart rot noticed in the previous trial was in fact caused by soil deficiency of boron.

Locality.—Horticultural Station, Molo. Block B.

Altitude.—8,200 ft.

Soil type.—Medium, dark loam.

Rain during experiment.—30.10 in.

Date of commencement.—4th July, 1951.

The variety used was "Red Long", seed obtained locally. The first sowing took place on 11th May, 1951, but was severely damaged by cutworm shortly after germination. The plot was completely resown on 4th July, 1951, dressing the seed with Agrocide 3 and drilling it thickly—approximately 15 lb. per acre.

Layout

Randomized blocks—five treatments, each replicated six times.

1—Control.
2—10 lb. per acre boron.
3—20 lb. per acre boron.
4—40 lb. per acre boron.
5—80 lb. per acre boron.

Each plot consisted of five rows about 20 ft. long of which the outer rows were treated as guard rows leaving three rows which were recorded for yield.

The result of the trial was as follows:—

Treatment—lb. boron per acre	Yield per acre	Disease per cent
0	56,584	32·9
10	68,024	36·5
20	68,112	44·2
40	60,104	37·3
80	66,264	35·2

Harvesting started on 11th January, 1952.

The results are not significant, expressed either as yield per acre or percentage roots showing deficiency symptoms.

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Meteorological

Rainfall throughout the pyrethrum-growing areas was exceptionally heavy during the course of the year and this was reflected in lower yields and contents, the former, it is considered, largely on account of the marked degree of water-logging experienced. The average pyrethrins content for the Colony for 1951 was 1.49 per cent as compared with 1.56 per cent for 1950.

The experimental stations were no exception to the abnormal rainfall experienced, totals for the year being as follows:—

Ol Joro Orok (7,800 ft.): 56.81 in.
Molo (8,300 ft.): 61.38 in.
Marindas (9,000 ft.): 59.44 in.
Subukia (7,000 ft.): 63.22 in.

The cloudy, overcast conditions experienced during the greater part of the year might have been expected to have been conducive to a greater incidence of bud disease but this does not appear to have been the case. It remains to be seen whether the meteorological conditions in 1951 will be reflected in the bud disease incidence during the 1952/53 season.

Detailed meteorological data for the experimental stations are appended.

Experimental Work

(a) Spraying Trial with Tulisan and Perenox on Mr. Pell-Smith's Farm, Molo

This observational trial was started in 1950 with the main object of determining whether frequent spraying of fairly large plots (¼ acre) within a bud disease infected plantation, where reinfection is constantly possible, would produce any obvious and visible results. Later on it was decided to make bud counts in certain control lines within the treatments. It is thought that, owing to the distance of Mr. Pell-Smith's farm from the Molo Experimental Station, with the consequent difficulty of supervision, that some healthy flowers were picked by labourers off the control lines as part of the normal farm routine. Such indiscriminate picking of healthy flowers would of course tend to increase the bud disease rate as a whole. The figures which follow must therefore be treated with reserve; there would, however, appear to be an indication that Perenox has depressed the bud disease rate.

Final figures for the 1950/51 and 1951/52 seasons are as follows:—

	1950/51 Disease Rate	1951/52 Disease Rate	Mean for both seasons
Control	23·1	43·2	32·7
Tulisan	21·6	63·9	35·3
Perenox	15·0	22·1	18·6

An application of the x^2 analysis to these figures indicated a very significant difference ($P = 0.01$) between Perenox and the control.

Spraying was carried out at monthly intervals, except during the dormant season, at the rate of 8 lb. Tulisan and 5 lb. Perenox, each in 100 gallons of water

per acre. During the 1951/52 season Alboleum was added to the mixture at the rate of 12 pints per 100 gallons.

The effect of Perenox in controlling bud disease is, as an economic proposition, open to doubt but the experiment has at least indicated the desirability of further research work with copper sprays.

(*b*) *Spraying Trials with American Fungicides, Molo*

This replicated trial was inaugurated in 1950 to determine the effect of various fungicides received from the U.S.A. on the control of bud disease.

Parzate, Fermate and Zerlate were applied at the rate of 2 lb. in 100 gallons of water per acre, Dithane at the rate of 1½ lb. in 100 gallons of water per acre and Phygon (1951/52) at the rate of 1 lb. in 100 gallons of water per acre. Sprayings were carried out at monthly intervals.

Results obtained during the 1950/51 and 1951/52 seasons were as follows:—

	1950/51 Disease Rate	1951/52 Disease Rate
Control	2·7	5·8
Parzate	4·2	3·9
Fermate	2·4	6·1
Zerlate	4·7	5·3
Dithane	3·1	4·3
Phygon	—	4·7

The disease rate is determined by the number of diseased buds picked per 100 healthy flowers picked. One row in each plot (300 sq. ft.) is used for making the bud counts.

No significant effect of any of these fungicides could be observed at such generally low disease rates.

(*c*) *Bud Disease Spraying Experiment, Ol Joro Orok*

This experiment was laid down in 1951 to determine the effect, if any, on the control of bud disease of spraying a strain of pyrethrum particularly susceptible to bud disease with a solution of zinc sulphate at various levels. It had previously been found in the Belgian Congo that spectrophotometric analyses of diseased buds indicated them to be deficient in zinc and it was thought that spraying with zinc sulphate might have some effect in controlling the disease.

Results for the 1951/52 season are inconclusive but the experiments are being continued.

(*d*) *Bud Disease Cultivation Experiments, Ol Joro Orok*

These observational experiments were laid down in 1951 to determine the effect, if any, on the control of bud disease of—

(*a*) hand weeding with *pangas* (cutlasses) versus weeding with *jembies* (hoes);

(*b*) cutting round the sides of the plant with a *panga* to depths of 6 in. and 12 in. versus no cutting;

(*c*) trimming, i.e. removing the dead stalks from the plant at the end of each flush versus no trimming, i.e. the dead stalks were left on the plant.

These experiments were in the nature of a repetition of previous experiments carried out in the Belgian Congo where it had been found that weeding with *jembies* and interference with the root system by cutting tended to increase the incidence of bud disease, whilst trimming tended to decrease its incidence.

The experiments at Ol Joro Orok were carried out on standard clones. No differences have been evident in Experiments (*a*) and (*c*) but in Experiment (*b*) figures for the disease rate at the end of the season were as follows:—

Cutting to 6 in.: 16.50.

Cutting to 12 in.: 23.16.

Control (no cutting): 16.14.

The experiments are being continued.

(e) Co-operative Bud Disease Experiment, Ol Joro Orok

Postcard returns continued to be submitted during 1951 from growers in all districts in the pyrethrum-growing areas showing the results of weekly disease rate counts on plants of Clone 24.

The mean disease rate for the year, according to these returns, was 9.43 diseased buds per 100 healthy flowers picked. This is slightly lower than in 1950/51 when the disease rate was 11.40. Field observations suggest that the general incidence of bud disease in 1951/52 was no worse than in 1950/51.

As in previous years, the results of the counts received from growers in districts east of the Rift Valley were contrasted with the results of the counts received from growers west of the Rift Valley. During the 1951/52 season it was found that the incidence of bud disease east of the Rift Valley was almost double that west of the Rift Valley, the average disease rates being 12.25 and 6.74 respectively.

These results for the comparison of east versus west are a complete reversal of previous experience. Admittedly fewer growers from districts east of the Rift Valley submitted returns during 1951/52 and it is stressed that this experiment is very much of an observational nature and that there is no check-up on the reliability of the returns received. Nevertheless, a complete reversal of experience of this nature, however observational, requires explanation and this remains to be sought.

Results of the counts for the past three seasons are as follows:—

1949/50

	No. healthy flowers picked	No. diseased buds picked	Disease Rate
East of Rift..	12,379	568	4·6
West of Rift	18,470	2,106	11·4
TOTAL ..	30,849	2,674	8·7

1950/51

	No. healthy flowers picked	No. diseased buds picked	Disease Rate
East of Rift..	40,169	3,442	8·6
West of Rift	20,403	3,435	16·8
TOTAL ..	60,572	6,877	11·4

1951/52

	No. healthy flowers picked	No. diseased buds picked	Disease Rate
East of Rift	22,701	2,780	12·25
West of Rift	23,833	1,607	6·74
TOTAL ..	46,534	4,387	9·43

(*f*) *Large Rotation Trial, Ol Joro Orok*

This trial was laid down between 1947 and 1949 with the object of determining the proper place of pyrethrum in a balanced system of rotational farming.

The trial is designed to test the following rotations with varying quantities of fertilizer:—

Continuous Pyrethrum.
Pyrethrum : Cereals.
Pyrethrum : Grass : Grass.
Pyrethrum : Grass.
Pyrethrum : Pyrethrum : Grass.
Pyrethrum : Cereals : Grass.

Each crop remains on the ground for a period of three years.

Reference is made to this Section's Annual Report for 1950 in which the preliminary results to the end of 1950 are given. This trial is, of course, still in its early stages and little more can be said at this stage. There would, however, appear to be indications that phosphates, in accordance with past experience, increase the yield of pyrethrum in the first year only and that applications of compost have a "delayed-action" effect which becomes manifest in the third year. All results to date are, however, statistically insignificant.

(*g*) *Small Rotation Trial, Ol Joro Orok*

Reference is again made to this section's annual report for 1950 in which the results to the end of 1950 for this trial, laid down in 1946, are given.

During the 1951/52 season this trial was again planted entirely to wheat, to determine the residual effects, if any, of previous fertilizer applications. There are no indications that any such exist.

(*h*) *Green Manure Rotation Trial, Molo*

This trial was undertaken in 1948 with the object of testing the effect of green manures and wheat, planted for one year only, upon a subsequent pyrethrum crop.

All the plots in the trial had been under pyrethrum for three years when the latter was uprooted in 1948.

Two plots in each block of the trial were planted up with sunflowers and lupins respectively. The remaining three plots in each block were sown with wheat. All plots received triple superphosphates at the rate of 60 lb. per acre. The two green manure crops were dug in at the appropriate stage and the wheat was harvested as a grain crop.

In 1949 all plots were planted again with pyrethrum (selected plants *ex* C.1 (14 x 24)). No fertilizers were applied with the pyrethrum to those plots which had borne sunflowers and lupins nor to one lot of the plots which had been under wheat. The other two lots of plots which had been under wheat, however, received a dressing with compost at the rate of ten tons per acre. One lot of these wheat plots was dressed in addition with 60 lb. per acre of triple superphosphates whilst the other lot had Uganda rock phosphate incorporated in the compost.

In the first (1949/50) season no significant results were obtained from this trial. The average yield was 253.9 lb. of dry flowers per acre. The former wheat plot which received no further manurial treatment yielded the least. Applications of compost and phosphates had been repeated.

During the 1950/51 season the average yield was 1,037.7 lb. of dry flowers per acre. The lowest yield was produced by the former wheat plot which received no further fertilizer applications. The best yields were obtained from the former wheat plots which had received compost and phosphates, statistically very significant increases (P = 0.01).

Compost and phosphates were again applied early in the 1951/52 season and it was found that immediate increases in yield were obtained by these treatments. Later in the season, however, this effect was not so marked until the late December rains brought the compost/phosphate plots to the fore again. By the end of the season these plots were very significantly (P = 0.01) superior to the former wheat only and lupin plots.

Results for the 1950/51 and 1951/52 seasons are as follows:—

	Weight dry flowers lb. per acre	
	1950/51	1951/52
1. Wheat—3 years pyrethrum	886·0	831·5
2. Wheat—3 years pyrethrum plus Compost and triple supers	1,122·0	1,150·7
3. Wheat—3 years pyrethrum plus Compost and Uganda Rock	1,112·3	1,220·8
4. Sunflowers—3 years pyrethrum	1,005·0	1,012·6
5. Lupins—3 years pyrethrum	1,063·2	952·5

(i) Shading Trial, Molo

This observational trial was laid down in 1950 with the object of determining the effect of shade, if any, on the incidence of bud disease. It was thought that by the construction of artificial shade above the pyrethrum plants a micro-climate might be created which would simulate cloudy weather conditions, with a possible increase in the bud disease rate.

The trial was carried out on Clone 194. To begin with, two treatments only were applied: Control (no shade), and 90 per cent shade. It soon became obvious that the main effect of the dense shade was to decrease flower production. In 1951 a further treatment consisting of 40 per cent shade was added. Results to date are as follows:—

	No. healthy flowers	Total weight flowers	Mean flower weight	No. diseased buds	Disease Rate
		gm.	*gm.*		
Control	5,874	4,493	0·76	178	3·0
40 per cent Shade ..	5,510	4,322	0·78	204	3·7
90 per cent Shade ..	3,167	2,286	0·72	141	4·5

The bud disease rate was low throughout.

An analysis by x^2 of the figures for control and 90 per cent shade showed a very significant difference (P = 0.01) between the bud disease rates.

A chemical analysis of a picking of flowers showed no differences in content between the shaded and control plots.

(*j*) *Seed Germination and Seasonal Influence on Percentage Germination Trial, Molo*

This trial has now been carried out over two complete seasons. Clone 297 was chosen for the purpose and, from this, seed was harvested every month and subjected to germination tests. It has been found that the percentage germination varies considerably with the time of harvesting.

Mean temperatures for the two months preceding the harvesting date, whilst the seeds were forming, were correlated with the germination percentages obtained after harvesting and a significantly negative correlation was obtained, in other words the lower the temperature the higher the germination. Similarly the rainfall for the two months preceding harvesting was correlated with the germination percentages obtained after harvesting and a significantly positive correlation was obtained, in other words the higher the rainfall the higher the germination.

The nature of these correlations is not altogether unexpected since mean temperatures are generally lower during periods of heavy rainfall. It is open to question, however, whether it is the higher rainfall in itself or the lower temperatures caused by it, or a combination of both factors, which is responsible for the increased germination percentages.

(*k*) *Hormone-spraying Experiment, Ol Joro Orok*

A small experiment was laid down at Ol Joro Orok in 1951 to test the effect of spraying blind (non-flowering) plants with TIBA (tri-iodo-benzoic acid). Good results with this hormone had previously been obtained in the U.S.A. on the stimulation of flowering of other crops, notably beans.

No effect on the blind plants under treatment at Ol Joro Orok could be observed.

(*l*) *Pentox-spraying Experiments, Ol Joro Orok*

Small preliminary experiments at Ol Joro Orok in which pyrethrum plants and the surrounding weed growth were sprayed with Pentox I and Pentox II at various levels indicated Pentox I to have a damaging effect on the weed growth, notably sorrel, pig-weed and Mexican Marigold, whilst the pyrethrum plants were undamaged. In all previous trials with weedicides whilst the weed growth has been controlled the pyrethrum itself, too, has been damaged.

Pentox I is a mineral oil received from the U.S.A. It contains no active chemical constituent. The experiments are to be continued.

Plant-breeding

A total of 1,054 single plant selections were under observation at the experimental stations during 1951.

Twelve variety trials, in their first- to their third-year stages, were being carried out on the experimental stations. Very promising results have been obtained from a number of crosses, notably C.48 (188 x P), C.45 (188 x 194) and Congo 1949. These were in 1951/52 all in the second-year variety trial stage and have given more promising results than many crosses in the third-year variety trial stage. It remains to be seen whether or no they will maintain their present performance. Other high-performance crosses are C.57 (194 x 486), C.77 (468 x 486) and C.79 (468 x P).

A start was made at Molo on a system of line-breeding in which a number of clones selected for (*a*) high altitude and (*b*) low altitude, and within each of these categories (*a*) high yield of flowers and (*b*) high pyrethrins content, are crossed one with the other in isolated plots. It is proposed that in 1952 the progeny of the low-altitude crosses should be taken to Subukia for further testing and selection.

After the first crosses have been made it is proposed that two separate lines of work should be pursued:—

(*a*) The seed would be mixed and the seedlings therefrom planted up in a seed-production field for the immediate issue of seed to growers.

(*b*) Testing and selection would be carried out within the crosses and line-breeding continued.

During 1951/52, 41 new crosses were being made in isolated plots at Ol Joro Orok and Molo in the normal course of breeding work. Those crosses that produce viable seed will be laid down in variety trials during the 1952/53 season.

Approximately 3.3 acres of C.47 (188 x 214) were under seed production during the year. Of this total, 2 acres were being grown under irrigation on the Ol Joro Orok and Molo Experimental Stations and 1.3 acres were being grown by four farmers at Kaptagat, Subukia and Thomson's Falls. Five hundred and eighty-seven pounds of seed were delivered to the Pyrethrum Board during the year.

Production of seed of 1970 Control and Molo Bulk continued at the Molo Experimental Station, deliveries of these strains to the Pyrethrum Board during the year amounting to 96 lb. and 194 lb. respectively.

A small seed-production field of approximately $\frac{1}{4}$ acre of C.43 (145 x P) was laid down on a private farm at Molo. This cross appears to be suitable for the 7,000–8,000-ft. altitude range. It is hoped to issue seed of this cross during the coming season.

Clones 127 and 481, the parents of C.51, were bulked-up vegetatively at Molo during the course of the year and a seed-production field of approximately one acre will be laid down at Molo in 1952. It is expected that seed of C.51 will be available early in 1953. This cross has given its best performance at the higher altitudes.

A large number of seedlings from various new crosses produced on the experimental stations were planted out in bulk to provide material for new selections. The vegetative propagation of Clones 362, 468 and 486, the parents of high-performance crosses, was started at Molo.

Seed is no longer being produced of the strain of pyrethrum bred by Mr. O. E. Hopley of Subukia which was mentioned in this Section's Annual Report for 1950.

The areas under seed production of C.47 and 1970 Control at the experimental stations are to be considerably extended during the 1952/53 season.

Pests and Diseases

No spectacular outbreaks or infestations were experienced during the course of the year. The incidence of root-rot was notably higher than usual, largely, it is believed, on account of the greater degree of waterlogging experienced as a result of the heavy rains.

The usual cases of eelworm, thrips, etc., were experienced but there did not appear to be any marked increase in their incidence.

Bud disease has been dealt with in separate sections.

Influence of Temperature on Pyrethrins Content

Regressions on the influence of temperature on pyrethrins content for three pyrethrum-growing areas were worked out during the year and in every case it was found that with decreasing mean temperatures an increase in pyrethrins content takes place. It is thought that this may be the main reason for the greater pyrethrins content at the higher altitudes.

Publications

A revised edition of "The Cultivation of Pyrethrum in Kenya" was prepared by Mr. E. W. Gaddum, Senior Agricultural Officer (Pyrethrum), during the course of the year and was published by the Pyrethrum Board.

Acknowledgments

Acknowledgments are gratefully made to members of the Pyrethrum Research Advisory Committee and to Mr. N. H. Hardy, Executive Officer of the Pyrethrum Board, for their unfailing assistance throughout the year.

Thanks are due to Mr. J. Glover, Plant Physiologist, East African Agriculture and Forestry Research Organization, for his ready help and co-operation in the investigation of bud disease problems.

Finally, the ready assistance and co-operation of the staff of this section is to be recorded and gratefully acknowledged.

F. H. ORMEROD,
Agricultural Officer (*Pyrethrum*).

APPENDIX

Meteorological Data

(*a*) *Ol Joro Orok.* (*Altitude* 7,800 *ft.*)

	Mean Temp.	Rainfall
1951	°*F*	*in.*
January	57·4	0·15
February	58·6	0·14
March	59·6	4·01
April	59·1	14·45
May	57·8	6·12
June	56·0	2·39
July	55·2	4·72
August	55·3	6·23
September	54·2	2·01
October	57·0	4·67
November	58·1	3·84
December	58·0	8·08
Mean	57·2	
Total		56·81

(*b*) *Molo.* (*Altitude* 8,300 *ft.*)

	Mean Temp.	Rainfall	Sunshine
1951	°*F*	*in.*	*hrs.*
January	57·0	0·79	233·4
February	57·4	0·67	219·4
March	59·3	5·10	181·5
April	57·8	17·60	54·1
May	56·9	4·80	218·4
June	55·6	2·55	190·0
July	54·2	3·79	184·2
August	54·4	5·55	120·4
September	56·2	1·54	174·7
October	56·3	2·75	183·6
November	56·9	4·29	192·7
December	59·9	11·95	184·7
Mean	56·8		
Total ..		61·33	2,137·1

(c) *Marindas.* (*Altitude* 9,000 *ft.*)

	Mean Temp.	Rainfall
	°*F*	*in.*
1951		
January	55·8	0·70
February	55·9	1·05
March	58·4	5·84
April	54·5	15·62
May	54·5	4·50
June	53·4	3·40
July	51·1	2·30
August	52·0	6·08
September	53·9	2·13
October	54·5	2·65
November	54·6	5·30
December	53·9	9·87
MEAN	54·4	
TOTAL		59·44

(d) *Subukia.* (*Altitude* 7,000 *ft.*)

	Mean Temp.	Rainfall
	°*F*	*in.*
1951		
January	63·2	0·25
February	64·5	0·12
March	64·2	4·52
April	62·0	13·14
May	60·3	6·49
June	60·4	2·58
July	59·6	6·32
August	60·7	4·47
September	61·0	2·14
October	61·1	5·51
November	61·2	9·77
December	61·3	7·91
MEAN	61·7	
TOTAL		63·22

ANNUAL REPORT OF THE SENIOR CHEMIST (PYRETHRUM), 1951

Observations since grading-by-analysis began have indicated that production of pyrethrum and pyrethrin content was closely allied to the rainfall of the previous month. There is a reverse relationship between production and pyrethrin content, i.e. if the production is comparatively low, the pyrethrin content will be high; vice versa if the production is high, the pyrethrin content drops. Therefore this year, with the very-well-distributed rainfall at the beginning we had hoped for a heavy production and a satisfactory pyrethrin content. On the contrary, the greater part of the year production has been lower than the previous year notwithstanding the greater number of growers, while the pyrethrin content has been most disappointingly low. Also less growers have averaged over 2 per cent for the monthly consignments. True, towards the end of the year the production has been comparatively large, but, nevertheless, the pyrethrin content was not what would have been expected. One can only conclude that the long, concentrated, very evenly distributed rainfall had an adverse effect upon pyrethrum.

TABLE I—KENYA PRODUCTION

	1950		1951	
	Flowers	Pyrethrins	Flowers	Pyrethrins
	lb.	*per cent*	*lb.*	*per cent*
January	243,166	1·50	290,495	1·49
February	211,173	1·49	186,963	1·38
March	152,509	1·37	81,415	1·43
April	90,543	1·49	43,133	1·30
May	45,185	1·60	40,909	1·51
June	169,165	1·62	214,082	1·46
July	354,389	1·61	456,930	1·49
August	422,470	1·67	568,120	1·63
September ..	453,611	1·70	545,202	1·57
October	550,936	1·58	526,504	1·48
November ..	752,440	1·52	606,566	1·57
December ..	671,624	1·56	653,813	1·55
TOTAL ..	4,117,211		4,214,132	
	Average = 1·57 per cent		Average = 1·53 per cent	
No. of growers over 2 per cent	91		16	

Experiments

By far the greater part of the experimental work in the laboratory has been concerned with losses in storage which, of course, covers losses in transit. Last year, and the early part of the year under review, it appeared that there were phenomenal losses between the baling of the flowers at Nakuru and the sampling

of the bales on arrival at New York. Figures of 15 per cent to 25 per cent were quite common. It is, therefore, not surprising that the Pyrethrum Board demanded experimental work to ascertain how to obviate these losses. Thus many experiments were laid down.

A.—Large Baling Experiment.—Commercial bales were prepared and shipped using six treatments, replicated:—

(i) Untreated. Normal storage.

(ii) Treated with the usual anti-oxidant. Normal storage.

(iii) Treated with gaseous sulphur-dioxide at 400 p.p.m. Normal storage.

(iv) Untreated. Cold storage at 35° F.

(v) Untreated. Cold storage at 50° F.

(vi) Untreated. Baled at half normal pressure. Normal storage.

As each bale was made up samples were drawn for analysis. The analytical results showed that the standard deviation for Py.I, Py.II and Total Pyrethrins was of the order of 0.04 per cent, a very satisfactory figure. Applying Fisher's "t" test to the duplicates of the treatments, the variation was insignificant. We, therefore, hoped for real information from this experiment.

However, the bales in cold storage were removed early in the voyage to normal storage. This was bad enough but the duplicate samples that we asked for from New York showed that the ground samples had been mixed, with the result that we were uncertain as to what bale any one sample referred!

B.—The next experiment was an attempt to ascertain the effect of the anti-oxidant in baling pressure. One untreated bale was made up and pre- and post-baling samples taken. One bale of flowers treated with anti-oxidant was baled, pre- and post-baling samples being taken. Core samples were taken from each bale one month later.

It appeared that the anti-oxidant had had some preservative effect, but in view of previous inconclusive results, the experiment was regarded as abortive on account of lack of replication.

C.—Among the many suggestions made was one to the effect that High Content flowers deteriorated at a very much greater rate than did Low Content flowers. Accordingly, an experiment was planned in which loose flowers were stored in paper bags and in sealed containers. The H.C. flowers contained 2.11 per cent and the L.C. flowers contained 1.78 per cent pyrethrins at the beginning of the experiment. Samples were very carefully drawn from each and parallel samples were stored in sealed jars and in paper bags, loosely closed, and stored in the laboratory. Analyses were made at two-weekly intervals up to 12 weeks.

In the H.C. material there was a slow loss of pyrethrins, nothing like what was feared, and, furthermore, there was no significant difference between the losses from the flowers stored in the sealed containers and those in paper bags; at times there were apparent increases over the original analyses.

In the L.C. material again there was a general slow loss but, in this case, the flowers stored in the sealed containers had a significantly higher pyrethrin content than those stored in paper bags. Again, during the course of the experiment there were, in some cases, apparently increases.

It was felt that this experiment was inconclusive. Properly designed, there should have been replications, and without these any attempt to draw conclusions might lead one to incorrect conclusions. The experiment was not repeated because of the immense amount of labour required and at the time of its conclusion other experiments of greater importance had been planned.

D.—During our visit in the Belgian Congo it was observed that the Congo flowers were less liable to shattering than Kenya flowers, in the same way that Kenya flowers are more stable than are those from the Southern Highlands of Tanganyika. It was felt that possibly the Congo flowers contain more resinous matter than Kenya flowers and these resins would probably help in producing a more compact bale into which air would not penetrate so readily. Accordingly, powder from Congo flowers and from Kenya flowers were extracted successively, in one case with petroleum ether, ethyl ether and chloroform, the extracts evaporated to dryness and weighed. Petroleum ether extracts were surprisingly high, being of the order, in both cases, of 7 per cent. normally petroleum ether extracts are about 4 per cent of the weight of the flowers but then this increase may be ascribable to the greater pyrethrin content of the new strains in both countries. Ethyl ether and chloroform extracted appreciably larger quantities of material from the Congo flowers than from the Kenya flowers.

Two further experiments were made in which extraction was made direct with chloroform. Again, the Congo flowers gave appreciably higher extraction than did Kenya. In the second of these experiments both Kenya H.C. and L.C. were included and it is interesting to record that the H.C. gave approximately 2 per cent more extract than did the L.C. In a subsequent experiment described below it was found that the L.C. flowers shattered very much more than did the H.C. flowers.

E.—Collaborative Work with O.P.A.C. on Losses in Storage.—Early in the year it was found that we and analysts in the U.S.A., on reputedly parallel samples of powder, did not agree in our analytical results. We arranged with O.P.A.C., at Costermansville, that they and ourselves would analyse, simultaneously, two parallel samples of pyrethrum powder. The results of two series of analyses were gratifyingly close, not only in total pyrethrins but in the figures for Py.I and Py.II. It was thus very patent that, provided the same method of analysis was employed and care was taken in the analysis, practically identical results could be obtained in two different laboratories.

As a result of this confidence in each other a collaborative experiment was laid down to ascertain whether there were differences in the rates of loss of pyrethrins in storage between Congo flowers and Kenya H.C. and Kenya L.C.

The basis of this experiment was that we were to receive a quantity of typical Congo flowers and that we were to supply quantities of Kenya H.C. and Kenya L.C. flowers. As far as possible these quantities were to be parallel in constitution. The two lots of Kenya flowers were very carefully treated so as to produce parallel materials. The flowers as received from Nakuru, in two qualities, were separately mixed on a tarpaulin using a shovel to heap them up into conical piles. After three or four turnings the piles were divided into four quarters, two of which were placed *in toto* into a bag and despatched by air mail to Costermansville, and the other two retained here. As far as possible, therefore, the quantities used at the S.A.L. and at O.P.A.C. for the experiment were identical. Flowers were brought by ourselves from the Congo and a further sample was received from them. It was arranged that, from these quantities of flowers, samples would be drawn, stored in sealed containers, analysed at different dates by identical methods of analysis, and that "moisture and volatile" would be determined by an agreed method. The method employed at the S.A.L. for drawing the individual samples was one which had been found to give satisfactory results in previous work, and consisted in thoroughly mixing the material, flattening it out into a low heap and taking samples by the grab method to the whole depth of the material, maintaining vertical walls at the various holes made, thus ensuring that all detached achenes were secured. Each sample consisted

of at least five such grabs. Unfortunately pressure of work prevented us from adhering completely to the programme. Two analyses in each case were not made. Nevertheless our series covered three analyses. O.P.A.C. were unable to deal with their own material. Thus the data are not as full as we desired. However, the conclusion to which we arrived after thorough statistical analyses was that the data were heterogeneous. The Congo figures differed from ours very greatly not only in the individual results but, in the Py.I and Py.II ratios, theirs varied very considerably. Further examination of the results proved the differences between ourselves and the Congo were highly significant. In view of the very close concord obtained from the analysis of the parallel powder samples, it is highly dubious that these differences could be due to procedure: there must be some other factor involved.

In addition to the experiment as designed with our Congo collaborators, we had decided to enlarge the experiment by introducing miniature bales. This was done because it had been observed that it had been the practice in the Congo to increase the moisture content of the flowers prior to baling. This procedure gave a very compact and close-textured bale. In this miniature-bale experiment samples were drawn as described above, half were sprayed with water in amount calculated to increase the moisture content by approximately 5 per cent. The moistened flowers were permitted to condition for about one hour before baling. There is no doubt that this treatment did give more compact bales.

In the first experiment, flowers brought by ourselves from the Congo were used. Bales were stored and analysed after a period of four months. There was no significant difference in the pyrethrin content between the wet and dry bales while the loss of content was inappreciable.

In the second experiment the second consignment of Congo flowers, Kenya H.C. and Kenya L.C. flowers, referred to in the previous experiment, were used. Again dry and moistened flowers were employed and the miniature bales from each material and treatment were analysed at two months and four months. There were anomalies in the results but on the whole it would appear that the added moisture had had no effect upon the loss of pyrethrins.

F.—In view of the anomalous results recorded in the above-mentioned experiment it was decided to reinvestigate the subject of the sampling of whole flowers both in bales and loose. In the first experiment, 16-core samples were drawn from a single bale, and these samples were analysed in duplicate as quickly as possible. An analysis of variance was calculated. The between-sample variance was highly significant in respect to the within-sample variance. This experiment has demonstrated how little reliance can be placed upon the present method of sampling employed in New York. It was interesting to record that in 1935 Mr. Gnadinger refused to sample whole flowers, in our collaborative work, and drew his samples from the powder resulting from the sample bale.

The second experiment is more crucial. Ten pounds of flowers from an experimental cross strain were thoroughly mixed and divided into eight equal portions. Each of these samples was analysed in duplicate. The analysis of variance is given in the table below and it can be seen that the sampling error of this special material is so great as to make our previous experiments of no value whatsoever. One of the real reasons giving rise to this great variance lies in the breaking up of the flowers and the uneven distribution of the achenes in the mass. The more one mixes the greater is the heterogenity of the material being sampled.

TABLE III

TOTAL PYRETHRINS ON SAMPLES AS ANALYSED

SOURCE	S.S.	D.F.	Variance
Between samples	0·0982	6	0·0163
Within samples	0·0027	7	0·0004
TOTAL	0·1009	13	(F=40·75)

S.E. of determination (method) .. .. 0·02 (0·92%)
S.E. of sampling .. .. 0·127 (5·88%)

TOTAL PYRETHRINS ON DRY BASIS

SOURCE	S.S.	D.F.	Variance
Between samples	0·120903	6	·020150
Within samples	0·003334	7	·000476
TOTAL	0·124237	13	(F=42·33)

Further analysis of these results has led us to the conclusion that the minimum number of replications in an experiment involving whole flowers, is three, and this is just sufficient to allow of statistical analysis. It will be realized that in large experiments to investigate losses in storage the amount of work involved on chemical analysis will be very great.

However, it is appreciated by the writer and his staff that it is better, both for the industry and for the individual worker, that this enormous load of work be undertaken in order to secure truly reliable results.

In view of these conclusions, results of two or three small experiments that have been completed will not be reported as any finding derived from them would be unreliable.

G.—Wet SO_2 Process.—It is often suggested that during the process of drying, no matter how carefully this be done, there is a loss of pyrethrins. This loss, it is suggested, is due to the effect of the enzymes of the classes of oxidases and peroxidases. It has been stated that if fresh flowers are treated with sulphur-dioxide gas this loss does not occur. On the farm there might be danger if the gaseous process were employed since the gas chamber would have to be large for the accommodation of a day's heavy picking. A process has been worked out by a pyrethrum grower in which flowers are immersed for a period of 12 to 24 hours in a weak solution—0.3 per cent—of sodium bisulphite, after which the flowers are drained and dried. It is claimed that this procedure, at least in the dry weather, prevents the loss of pyrethrins during drying.

Two experiments have been made, the first during the rains and the second at the end of a long spell of dry weather. Freshly picked flowers were thoroughly mixed and quartered, diagonally opposite quarters being used for each sample—it is possible adequately to sample fresh flowers since these do not shatter in handling—one portion was dried immediately at a temperature below 140° F., the second portion was immersed in the bisulphite solution and allowed to soak over night; there was very marked alcoholic fermentation of the sugars in the

flowers and the solution had a very strong beery odour. After draining, the flowers were dried under the same conditions as the control. On assaying, the treated flowers had a higher percentage of pyrethrins than the control, but when the out-turn was calculated on the basis of the fresh flowers it was evident that there had been a marked loss of pyrethrins and that the higher percentage was due to the loss of dry matter brought about by the fermentation. In the dry-weather experiment the loss in pyrethrins was very much less. One must, therefore, conclude that this process is not worth while; it involves building tanks large enough to hold the day's picking, drainage racks and increased costs of drying.

Drying at High Temperatures.—Claims have been made, both in America and East Africa, that very much higher temperatures—even temperatures above the boiling point of water—can be employed, without any deleterious effects, in the drying of pyrethrum. In the last 20 years the writer has made many experiments on this subject and always it has been found that high temperatures, when the drying was carried to its conclusion, do lead to a loss of pyrethrins.

It has been suggested that there might be a difference in the make-up of the flowers in those parts of East Africa where it is claimed that drying can be done at high temperatures without loss of pyrethrins. This is possible, but hardly probable, in view of the fact that the writer's findings on Kenya pyrethrum were substantiated by Tattersfield and Jary using flowers grown at Harpenden and at Wye. There is a possible explanation of the claims; viz., that flowers are removed from the high-temperature drier while they still contain sufficient moisture which evaporation reduces their temperature to well below that of the circumambient air. Flowers would thus be removed from the drier in a partially dried state and the final drying done in the air. Whether this be the case it has been impossible to ascertain.

Acknowledgments

The writer wishes to express his thanks to the whole of his staff, permanent and temporary, European and African, for the very loyal service they have given during the past year. Were it not for this devoted service nothing like the volume of work could have been completed.

The writer wishes further to record his special thanks to Mr. Hopkins who, by working most Sundays, enabled the very large programme of experimental work to be completed.

Finally the thanks of the section are due to Dr. Webster for his unfailing interest and for his assistance in the planning of experiments.

V. A. BECKLEY,

ANNUAL REPORT OF THE AGRICULTURAL OFFICER IN CHARGE, HIGH-LEVEL SISAL RESEARCH STATION, THIKA, 1951

Meteorological

RAINFALL

January	0.15 in. in	1 day
February	Nil	
March	6.73 in. in	12 days
April	19.23 in. in	22 days
May	1.58 in. in	18 days
June	3.73 in. in	5 days
July	2.34 in. in	7 days
August	0.90 in. in	6 days
September ..	0.76 in. in	3 days
October	4.19 in. in	13 days
November ..	11.02 in. in	19 days
December ..	10.05 in. in	18 days
Total ..	60.68 in. in	124 days

The average rainfall for the ten years 1942–1951 is 33.31 in.

There was a severe drought during the first ten weeks of the year. The growth of all vegetation was brought to a standstill, as the partial failure of the short rains at the end of 1950 left little reserve moisture in the soil.

However, the long rains started on 12th March and both these and the short rains were heavy and prolonged, providing conditions suitable for the growing of sisal. The total rainfall for the year greatly exceeded that of any other year since recording started at the station in 1941.

Experimental Areas

There are at present nine major trials in progress on the station, of which three were cut according to programme. Growth records of leaf count and leaf length continue to be taken quarterly. No new trials were planted during the year. The heavy rains provided ideal conditions for the luxuriant growth of weeds and consequently the work involved in weeding was heavy.

Agave Hybrids

The hybrids which were originally introduced from Tanganyika have poled and nurseries of their bulbils have been planted for further trial. Plants, which produced marginal leaf spines, have been discarded and nine varieties remain with smooth-edged leaves. Six bulbils each of five new hybrids were received from the Sisal Research Station at Mlingano after having been quarantined to ensure that they were free from insect pests.

Grasses and Cover Crops

Molasses grass (*Melinis minutiflora*), Rhodes grass (*Chloris gayana*) and *Eragrostis curvula* continue to grow well at the station, and so far Molasses grass seems to produce greater bulk than the other two. An endeavour is being made to find leguminous cover crops which grow under the conditions obtaining in this area and in this connexion plots of *Astragalus somalensis, Crotalaria incana, C. intermedia, Dolichos* sp. and *Indigofera tettensis* have been

planted. The progress of the grasses and leguminous cover crops is being followed with great interest as growers are realizing that the maintenance of soil fertility is of paramount importance to the economic continuance of the sisal industry. The establishment of grass strips between sisal rows will assist greatly in the control of soil erosion and the regular cutting of the grass will provide valuable organic matter for the soil and it is hoped that the cover of mulch will offset the loss of moisture by transpiration of the grass. The cultivation trial at the station should provide valuable information on this subject.

Fruit and Forest Trees

About 14,500 eucalyptus seedlings in banana pots and 50 budded Washington Navel orange trees were distributed to sisal estates during 1951. In addition, over 3,000 eucalyptus trees were planted at the station.

Sale of Fibre

The production of fibre during 1951, which was 1.2 tons line fibre, 0.1 tons tow and 0.2 tons flume tow, was sold locally.

Water Supply

The severe drought during the latter half of 1950 and the early part of 1951 reduced the dam to a small muddy pool, with the result that the water supply was unsuitable for domestic use and for the washing of decorticated fibre. The unreliability of the water supply from the dam necessitated the sinking of a borehole, which proved to be successful.

Pests and Diseases

With the exception of the sisal weevil (*Scyphophorus acupunctatus*) which occurs on some estates in the Coast Province, sisal is remarkably free from insect pests. A team of specialists is carrying out investigations at the Sisal Research Station, Mlingano, in an endeavour to find a method of controlling the weevil. The Kenya sisal growers have contributed to the cost of this scheme and it is hoped that an economical method of control will be found.

Nutritional disorders, which are usually referred to as "deficiency diseases", have been noticed in several areas in Kenya—they are at present identified by certain leaf symptoms which are described as follows:—

(*a*) *Banding Disease.*—Yellowish or brown spots, which gradually coalesce into a band of dark brown necrotic tissue, develop at the base of the leaf. There is fairly conclusive experimental evidence that this disease is due to a deficiency of potash and its severity may possibly be related to the potash/nitrogen ratio of the soil.

(*b*) *Purple Leaf-tip Roll.*—The distal end of the leaf usually becomes yellow and then purplish in colour, the margins of the leaf, near to the tip, curl inwards and the leaf begins to dry off prematurely. The factors responsible for these symptoms are not known.

(*c*) *Leaf Tip Die-back.*—A small area of sharply defined, dark brown withered tissue develops immediately below the tip thorn. The cause of the disease is not yet known.

(*d*) *Parallel Streak.*—Fine pale-green striations forming a narrow band of affected tissue running lengthwise develop near the edges of the lower half of the leaf.

The causes are not understood but microscopical examination of leaf sections made at Mlingano shows that the symptoms are attributable to a breakdown of the palisade cells beneath the epidermis and that the damage appears to be superficial.

Scientific staff and equipment are being assembled at the Sisal Research Station, Mlingano, to study nutritional disorders of sisal. The most important of the deficiency diseases are common to both Tanganyika and Kenya and the close co-operation which exists between the two sisal research stations will ensure that the results of work on these problems at Mlingano will be available to the Kenya growers.

Investigational Work in Progress

CUTTING TRIAL

Object.—To investigate the effect of cutting on the sisal plant.

Date of commencement.—March, 1941.

Spacing.—12 ft. by 3 ft. (1,210 plants per acre).

Treatments.—Commencement of cutting: 3½ year, 4 years and 4½ years Interval between cuts: 6 months, 12 months and 18 months. Intensity of cut: light, leaving 36 leaves after each cut; heavy, leaving 12 leaves after each cut

Design.—3 by 3 by 2 factorial with 4 replications.

This trial was cut according to programme in February and August, 1951. A summary of results to date is given below:—

	First Cut at			Intervals Between Cuts			Intensity of Cut	
	3½ years	4 years	4½ years	6 months	12 months	18 months	Heavy	Light
No. of leaves lost over 24 in. ..	5·6	12·2	23·8	13·7	13·6	14·3	14·4	13·3
No. of leaves cut per plant	240·0	211·3	195·5	223·3	216·4	207·1	222·6	208·6
Wt. in lb. of leaves cut per plant ..	363·4	364·8	369·2	367·4	362·0	368·0	360·4	371·2
Tons of unbrushed fibre per acre ..	6·66	6·12	5·95	6·39	6·14	6·18	6·15	6·32
Poling percentage..	85·35	94·95	98·75	81·13	98·33	99·58	86·03	100·0

Analysis of the yield of line fibre continues to show that early cutting and light cutting are superior to late and heavy cutting respectively. The early cut in this trial was taken at 3½ years after planting and when the sisal had produced an average of 145 leaves per plant. Experience indicates that the early first cut was probably too late and trials are now in progress in which the early cuts are being taken when the average leaf count per plant is about 100.

All the light cut treatments poled out at an age of eight to ten years, but there is still a considerable number of plants in the heavy cut treatments which have not yet poled out at an age of almost 11 years. The gap between the yields of the heavy and light cut treatments will now continue to close as the heavy cut treatments are still producing leaves, whereas the light cut treatments were completed about a year ago. Thus although the differences in the final yields may be negligible the light cutting will still be better than heavy cutting as the former will have produced its crop in less time than the latter.

SPACING TRIAL

Object.—To investigate the effect of various spacings on sisal yields.

Date of commencement.—February, 1941.

Method of cutting.—First cut at 3½ years followed by cuts at yearly intervals.

Design.—Six randomized blocks.

The following table gives a summary of yield figures, etc., up to September, 1951:—

Spacing	15x4′	11x4′	18x3½x4′	12x3′	15x2′	22x2x2¼′	11x2½′	10x2′
Population ..	726	990	1,013	1,210	1,452	1,613	1,760	2,178
No. of leaves cut per plant	228·9	228·6	228·4	230·1	230·5	225·1	226·4	225·7
Wt. in lb. of leaves cut per plant ..	398·2	367·5	376·0	376·3	379·1	357·9	360·0	352·5
Tons of unbrushed fibre per acre ..	4·24	5·60	5·73	6·86	8·72	8·98	9·73	11·89
Poling percentage ..	100·0	100·0	100·0	100·0	98·96	92·71	100·0	96·88
Age at time of last cut or at 100 per cent poling ..	7½ yrs.	8 yrs.	9½ yrs.	9 yrs.	10½ yrs.	10½ yrs.	10½ yrs.	10½ yrs.
Yields per acre per year of cycle (tons)	0·57	0·70	0·60	0·76	0·83	0·85	0·93	1·13

It will be noted, from the figures for yield of fibre per acre, that the yield increases as the population increases and, what is even more important, the yield per acre per annum of the cycle also increases in spite of the fact that the cycle has been lengthened. Increases in population have not caused any appreciable shortening in the length of the leaves.

Planting Method Trial

Object.—To compare yields when using old suckers from overgrown fields, young suckers from two-year fields and nursery plants produced from bulbils.

Date of commencement.—24th April, 1949.

Spacing.—12 ft. by 2 ft. 6 in. (1,452 plants per acre).

Treatments.—Material: Old suckers, young suckers, nursery plants. Depth of planting: Deep, shallow.

Design.—6 by 6 Latin square.

The following table gives the average leaf counts at December, 1951:—

	Bulbils	Young Suckers	Old Suckers	Mean
Shallow	110·0	105·8	109·0	108·3
Deep	98·7	97·6	98·5	98·3
Mean ..	104·4	101·7	103·8	103·3

It will be noted that the shallow-planted material has produced about ten leaves more per plant than that of the deep. Analysis of the figures shows that the difference is highly significant. On the other hand, the leaf length of the deep-planted material was somewhat greater than that of the shallow, during the first 18 months of the cycle. The growth rates of the bulbils and old suckers are about the same and they are both somewhat better than that of the young suckers—this is probably due to the fact that the young sucker planting material was smaller than the others.

Thirty-two of the 36 plots were cut during the last quarter of the year at the 95–105 leaf stage. The remainder of the plots will be cut at a similar stage to avoid imposing a cutting treatment, which might mask the effects of the treatments being investigated. Examination of the figures from the plots, which have so far been cut, indicates that more leaves under 2 ft. have been lost in the shallow- than in the deep-planted material—this is probably caused by the greater leaf length of the deep-planted material during the first 18 months of the cycle

NURSERY MANURIAL AND MULCHING TRIAL

Object.—To compare the effects of fertilizers and waste, dug in and as a mulch, on the growth rate of bulbils.

Date of commencement.—28th November, 1950.

Spacing.— 2 ft. by 9 in.

Treatments.—

300 lb. of sulphate of ammonia per acre.
180 lb. of double superphosphate per acre.
120 lb. of muriate of potash per acre.
30 tons well-rotted sisal waste per acre, dug in.
30 tons well-rotted sisal waste per acre as mulch.

Design.—2^5 factorial.

Severe drought during the first few months after planting caused the loss of some of the bulbils and the need to supply the missing spaces has prevented the trial from being as regular as it could have been. Growth records are not kept on this trial as the effect of treatments will be measured by taking the weight of the plants when they are lifted. Distinct visual differences between plots are, however, noticeable and the best plots are those which received dressings of mulch and/or compost.

FERTILIZER TRIAL

Object.—To investigate the effect on the growth rate of sisal plants by applying artificial fertilizers and/or sisal waste.

Date of commencement.—16th March, 1950.

Spacing.—13 ft. by 3 ft. by 2 ft. 9 in. (1,980 plants per acre).

Treatments.—

(1) Sulphate of ammonia (N) applied at the rate of 388 lb. per acre in each of the first four years of the cycle.

(2) Double superphosphate (P), applied in shallow trenches under the plants a week before planting at the rate of 260 lb. per acre.

(3) Muriate of potash (K) applied at the rate of 395 lb. per acre for the first year and 300 lb. per acre during each of the next three years.

(4) Agricultural lime (Ca) (90 per cent Ca CO_3), broadcast over the whole treated area at the rate of 2 tons per acre a month before planting.

(5) Sisal waste (W) as fresh sisal waste taken straight from a Corona decorticator, decorticating dry. The waste was applied at the rate of 107 tons wet waste per acre and dug in one month before planting in strips covering an area four feet each side of the double rows.

Design.—2^5 factorial design.

The following table gives the responses to fertilizer treatments based on leaf count figures which were taken at the end of the year.

	Mean Response	Response With									
		Ca		W		N		P		K	
		−	+	−	+	−	+	−	+	−	+
Ca	2·65	—	—	4·16	1·14	3·35	1·95	4·45	0·85	2·31	2·99
W	10·89	12·39	9·36	—	—	13·17	8·57	13·15	8·54	10·19	11·56
N	3·31	4·01	2·61	5·61	1·01	—	—	2·17	4·45	3·36	3·26
P	5·34	7·14	3·54	7·61	3·06	4·20	6·47	—	—	4·71	5·96
K	−1·47	−1·81	−1·14	−2·16	−0·79	−1·42	−1·53	−2·10	−0·85	—	—

The analysis of the figures indicates that there is a very highly significant response to waste and phosphates, that there is a highly significant response to nitrogen and lime and that there is no response to potash.

The visible responses to fertilizer treatments, which can be seen in the field, are most striking. All the plots in this trial will be cut when they have attained a production of about 100 leaves per plant and it is likely that some of the more advanced plots will have reached this stage at about two years and three months after planting.

Parallel streak and leaf-tip die-back have appeared on the leaves of plants in this trial. Counts of the numbers of affected leaves have not yet given any indication of the causes of these abnormalities, but spectrographic analyses of the leaves and soil will be done in an endeavour to ascertain the causes.

Sisal Waste and Mineral Trial

Object.—To compare the effect of different methods of applying fresh sisal waste, waste reinforced with artificial fertilizers and fertilizers alone.

Date of commencement.—17th March, 1950.

Spacing.—13 ft. by 3 ft. by 2 ft. 9 in. (1,980 plants per acre).

Treatments.—

		Fresh Sisal Waste	Sulphate of Ammonia	Double Super Phosphate	Muriate of Potash	Agric. Lime ($CaCO_3$ 96 per cent)
		ton	*lb.*	*lb.*	*lb.*	*ton*
A	Control	Nil	Nil	Nil	Nil	Nil
B	Waste half dug in and half as mulch ..	107	Nil	Nil	Nil	Nil
C	Waste all dug in ..	107	Nil	Nil	Nil	Nil
D	Waste all as mulch..	107	Nil	Nil	Nil	Nil
E	Waste half dug in and half as mulch with minerals added ..	107	390	65	325	0·42
F	Waste all dug in with minerals added ..	107	390	65	325	0·42
G	Waste all as mulch with minerals added	107	390	65	325	0·42
H	Minerals only ..	Nil	1,560	260	1,300	2·0

(1) The waste, lime and superphosphate, were applied before planting as in the fertilizer trial. Sulphate of ammonia applied with waste at the rate of 129 lb. per acre for first year and 87 lb. per acre during each of the next three years. Applied without waste at the rate of 522 lb. for the first year and 346 lb. per acre during each of the next three years.

(2) Muriate of potash applied with waste at the rate of 130 lb. per acre the first year and 65 lb. during each of the next three years. Applied without waste at the rate of 520 lb. per acre for the first year and 260 lb. during each of the next three years.

Design.—Four randomized blocks of eight plots.

The following table gives the average leaf count per plant for the various treatments at an age of 18 months after planting:—

A	B	C	D	E	F	G	H	Mean
60·7	67·7	67·3	66·8	72·1	75·1	71·3	67·9	68·61

Analysis of these figures indicates the following trends: —

(1) There have been highly significant responses to the applications of waste and/or fertilizers.

(2) There is no difference between the three methods of applying waste.

(3) A full dressing of mineral fertilizers has given the same results as waste alone.

(4) Waste, which was fortified with small quantities of fertilizers, has given slightly better results than any of the other treatments.

CULTIVATION TRIAL

Object.—To investigate the effect on the soil and sisal plants of continuous clean weeding by mechanical means as against restricted weeding with and without a controlled grass cover in the area between sisal lines.

Date of commencement.—1st November, 1950.

Spacing.—13 ft. by 3 ft. by 2 ft. 9 in (1,980 plants per acre).

Treatments.—

(1) Grass strip slashed frequently to keep the grass low.

(2) Grass strip cut periodically and the cut grass used as mulch round sisal plants.

(3) Clean weeded by frequent disking for the first three years, then as (1).

(4) Clean weeded by frequent disking for the first three years, then disking twice a year.

(5) Disking twice a year for the whole cycle.

(6) Clean weeding by frequent disking for the whole cycle.

The trial incorporates the above treatments with sisal planted on the flat and on ridges. The grass cover is obtained by sowing Rhodes grass (*Chloris gayana*) in 6-ft. wide strips between the double rows, at the rate of 19 lb. of seed per acre of the area sown.

Design.—Four randomized blocks each of 12 plots.

So far, growth of the sisal has not been affected by cultivation treatments. It is probable that cultivation treatments will take a long time to affect the growth of sisal on new land.

PLANTING MATERIAL TRIAL

Object.—To investigate the possibility of obtaining greater efficiency by using larger nursery plants and an earlier first cut than is normal practice in Kenya.

Date of commencement.—3rd November, 1950.

Spacing.—13 ft. by 3 ft. by 2 ft. 9 in.

Treatments.—

Planting material: Nursery plants 9 in. high, weight about 1 lb.; nursery plants 15 in. high, weight 3–3¼ lb.; nursery plants 21 in. high, weight 6½–7 lb.

Age at first cut: Early, normal, late (to be decided at a later date).

Intensity of cut: Heavy, leaving 10 leaves after cutting; medium, leaving 20 leaves after cutting; light, leaving 30 leaves after cutting.

Design.—3^3 factorial, two replications confounded.

Analysis of the figures of leaf count shows that there is a highly significant difference in growth rate between each size of planting material in favour of the bigger plants.

Bulbils, Nursery Plants and Sucker Trial

Object.—To compare bulbils planted *in situ* in the field with nursery plants and suckers, and further to compare flat and ridged planting on red soils.

Date of commencement.—7th November, 1950.

Spacing.—13 ft. by 3 ft. by 2 ft. 9 in.

Treatments.—

(1) Bulbils of average weight 3 oz. planted *in situ* in fields.

(2) Nursery plants 15 in. high, weight 3–3¾ lb.

(3) Suckers from old areas 25 in. high, weighing 10–12 lb.

(4) Ridged versus flat.

Design.—6 by 6 Latin square.

The sisal in this trial is growing well but the difference in sizes of planting material is great and the main value of this trial will be in ascertaining the length of the period between planting and time of first cut.

Couch (*Digitaria scalarum*) Control Trials

Couch grass occurs in many sisal-growing areas in the Colony and it is both difficult and expensive to eradicate. When it became known that a herbicide, called Sodium T.C.A., might control couch, Messrs. Plant Protection, Ltd., kindly co-operated by putting down two exploratory trials at the station. Notes on the results to date are given below.

A.—Effect of post-emergent sprays with T.C.A. on young sisal in vigorously growing couch:—

(1) Early applications of T.C.A. during heavy rain periods appear to give better control of couch than late applications made after the heavy rains have finished, indicating that a root absorption of T.C.A. is more effective than foliage absorption.

(2) Fifteen pounds of T.C.A. per acre killed off the top growth of couch but the roots were not killed. Thirty pounds of T.C.A. per acre gave a more lasting control effect. Neither of these rates was completely effective for more than three months.

(3) Two applications of T.C.A. both at 36 lb. per acre, the first applied early in short rains 1950, and the second early in long rains 1951, gave an effective control of couch for 12 months. Slight regrowth after this period occurred showing that complete eradication was not achieved with these two applications.

(4) Slight scorch to the basal leaves of the sisal was observed at the 30 lb. per acre rate.

B.—Effect of pre-emergent sprays with T.C.A. which were applied to a heavily couch-infested area after one ploughing and harrowing. The sisal was planted about a fortnight after spraying:—

(1) Application of T.C.A. to bare soil of couch-infested land, prior to planting of sisal, shows more promise of controlling couch than the spraying of couch foliage.

(2) Retardation in emergence of grasses and broad-leaved weeds has been achieved with 10 lb. of T.C.A. for a period of four months (May to September, 1951). Twenty pounds of T.C.A. retarded emergence for a period of five months and 40 lb. of T.C.A. for a period of six months. The couch grass showed an estimated 50 per cent cover of the soil on the untreated plots six months after the final cultivation.

(3) Sisal plants growing in the T.C.A. plots showed better growth and a deeper green in colour than those growing in the untreated plots.

External Trials

The object of five of the external trials is to ascertain variations in growth rates in the various districts using different spacings and cutting treatments.

Treatments for all the trials are as follows:—

Spacings: 11 ft. between single lines; 14 ft. between single lines; 18 ft. by 3 ft. double-row planting.

Populations: 1,200 plants per acre; 1,600 plants per acre; 2,000 plants per acre.

Development at first cut: 100-leaf stage; 125-leaf stage; 150-leaf stage.

Severity of cutting: Light, leaving 30 leaves after each cut; medium, leaving 20 leaves after each cut; heavy, leaving 10 leaves after each cut.

Design.—3^4 factorial experiment arranged in 9 by 9 quasi-Latin square.

(1) Ruiru Trial (Black Cotton Soil) Ridged

Locality.—Juja Farm, Ruiru.

Date of commencement.—16th March, 1948.

Summary of results up to 1st December, 1951:—

Spacing—	Average Leaf Count Per Plant Space between rows				Leaf Length in cms. for the Last Unfurled Leaf Space between rows			
	11 ft.	14 ft.	18×3ft.	Average per plant	11 ft.	14 ft.	18×3ft.	Average per plant
Plants per acre								
1,200	112·8	109·9	117·8	113·5	100·0	102·6	107·1	103·2
1,600	101·7	96·9	102·3	100·3	97·4	97·2	99·5	98·0
2,000	97·7	91·3	97·5	95·5	98·1	98·6	97·8	98·2
Average per plant ..	104·1	99·4	105·8	103·1	98·5	99·5	101·4	99·8

The early first cut at the 100-leaf stage was made on 27 plots during June.

There is considerable unevenness of growth from plot to plot but not from plant to plant in any one plot. Consequently, it is clear that the growth heterogeneity is due to soil variations. Soil samples were taken from good and bad plots and their analyses give no indication that the considerable growth heterogeneity can be rectified by applying fertilizers. The plants on the poor plots are characterized by leaf chlorosis and dwarfed growth; these symptoms have been associated with waterlogging and with a nitrogen deficiency, the latter being able to arise not only from actual soil deficiency, but also from restricted root development. The one feature which was common to the higher-yielding plots was a high content of calcareous concretions or of rotting rock relatively near the surface of the soil. The one feature which was common to the poorer plots was a relatively great depth of uniform heavy clay loam topsoil. It therefore seems likely that the uneven growth can be attributed to variations in the physical properties of the soil as the deep clay soil becomes hard and cracks during dry seasons, thus making root penetration difficult.

(2) Trans Nzoia Trial

Locality.—Ziwa Estate, Ltd., Hoey's Bridge.

Date of commencement.—10th April, 1948.

Summary of results up to 1st December, 1951:—

Spacing—	Average Leaf Count Per Plant Space between rows				Leaf Length in cms. for the Last Unfurled Leaf Space between rows			
	11 ft.	14 ft.	18×3ft.	Average per plant	11 ft.	14 ft.	18×3ft.	Average per plant
Plants per acre								
1,200	132·3	128·4	126·8	129·2	92·1	93·4	91·5	92·3
1,600	122·7	120·4	121·3	121·5	91·3	93·9	91·9	92·4
2,000	116·0	111·1	116·7	114·6	90·0	92·2	93·1	91·8
Average per plant ..	123·7	120·0	121·6	121·8	91·1	93·2	92·2	92·2

The early first cut at the 100-leaf stage was made on 27 plots during July.

(3) Kampi-ya-Moto Trial

Locality.—Alphega Estate, Kampi-ya-Moto.

Date of commencement.—23rd October, 1948.

Summary of results up to 1st December, 1951:—

Spacing—	Average Leaf Count Per Plant Space between rows				Leaf Length in cms. for the Last Unfurled Leaf Space between rows			
	11 ft.	14 ft.	18×3ft.	Average per plant	11 ft.	14 ft.	18×3ft.	Average per plant
Plants per acre								
1,200	110·3	104·5	93·4	102·7	99·2	92·1	82·4	91·2
1,600	102·3	99·1	96·1	99·2	91·3	92·6	88·8	90·9
2,000	96·4	89·9	87·2	91·2	89·5	87·9	80·3	85·9
Average per plant ..	103·0	97·8	92·2	97·7	93·3	90·9	83·8	89·3

(4) Thika Trial—Red Soil

Locality.—Anglo-French Sisal Estate, Thika.

Date of commencement.—17th November, 1948.

Summary of results up to 1st December, 1951:—

Spacing—	Average Leaf Count Per Plant Space between rows				Leaf Length in cms. for the Last Unfurled Leaf Space between rows			
	11 ft.	14 ft.	18×3ft.	Average per plant	11 ft.	14 ft.	18×3ft.	Average per plant
Plants per acre								
1,200	124·2	119·1	114·3	119·2	107·9	107·0	102·1	105·7
1,600	115·1	107·0	105·9	109·3	105·5	106·8	98·8	103·7
2,000	108·6	96·9	103·4	103·0	106·8	101·5	103·9	104·0
Average per plant ..	116·0	107·7	107·8	110·5	106·7	105·1	101·6	104·5

The early first cut at the 100-leaf stage was made on 27 plots during August.

(5) Kibwezi Trial

Locality.—Dwa Plantations, Ltd., Kibwezi.

Date of commencement.—21st October, 1949.

Summary of results up to 1st December, 1951:—

Spacing—	Average Leaf Count Per Plant Space between rows				Leaf Length in cms. for the Last Unfurled Leaf Space between rows			
	11 ft.	14 ft.	18×3ft.	Average per plant	11 ft.	14 ft.	18×3ft.	Average per plant
Plants per acre								
1,200	76·0	74·1	75·5	75·2	88·0	88·9	87·7	88·2
1,600	75·5	70·9	70·4	72·3	90·9	90·2	85·1	88·7
2,000	70·7	64·4	63·4	66·8	90·6	87·8	85·2	87·9
Average per plant ..	74·1	69·8	70·4	71·4	89·8	89·0	86·0	88·3

(6) Ridging versus Flat Trial (Trans Nzoia)

Object.—To compare the relative merits of planting sisal on the flat and on ridges on the red soils in the Trans Nzoia area.

This trial is also being used as a Uniformity Trial.

Locality.—Adjacent to the main trial at Ziwa, Ltd., Hoey's Bridge.

Date of commencement.—11th April, 1948.

There are no differences between the growth rates of plants on the flat and on ridges. This trial was given a light first cut in July, leaving 30 leaves on all plants.

(7) Flat versus Ridged with Subsoil Treatment Trial (Kampi-ya-Moto)

Object.—To ascertain whether subsoiling or ridging will improve the rate of growth on the sandy soils of Kampi-ya-Moto area.

Locality.—Adjacent to the main trial on Alphega Estate, Kampi-ya-Moto.

Date of commencement.—24th October, 1948.

There are considerable differences in growth rates between plots, but analysis of the figures shows that the differences are attributable to soil variations and not to the treatments which are being tested.

(8) Banding Disease Trial

Object.—To ascertain whether muriate of potash will stop the development of leaves affected by banding disease and the amount of fertilizer required for the control of the disease.

Locality.—Fort Hall District.

Date of commencement.—Fertilizer applications were made on 17th December, 1949, to two-year-old sisal in a field affected by the disease.

Treatments.—Applications of muriate of potash: Nil; 110 lb.; 220 lb.; 330 lb.; 440 lb. per acre.

Design.—5 by 5 Latin square.

The incidence of the disease in the trial area varies too widely to permit of the figures being analysed statistically, but it can be said that the application of the muriate of potash at the rates used has not cured the disease although it appears that the heavier dressings have reduced, to a certain extent, the number of diseased leaves. A second application of fertilizer has been made to half of each plot at the same rate which was used in the first application. It is still too early to see the effect of the second application.

(9) Leaf-tip Die-back Trial

Object.—To ascertain whether applications of agricultural lime, double superphosphate, silica phosphate, single or in combinations, will prevent the drying up of the leaf tips.

Locality.—On red loam soil in the Thika District.

Date of commencement.—Fertilizers were applied on 8th March, 1950, in a field planted in August, 1947.

Treatments.—

Control	Nil.
Ca	2 tons $CaCO_3$ (96 per cent) per acre.
P	250 lb. double superphosphate per acre.
S	500 lb. silica phosphate per acre.
Ca + S	Rates as above.
Ca + P	Rates as above.

Design.—Three blocks of six randomized plots.

Analysis of the figures for diseased leaf counts do not show any significant differences between treatments, hence it is probable that the disease is not caused by a deficiency of lime or phosphates in the soil.

Acknowledgments

Messrs. Anglo-French Sisal Co., Ltd., have continued to assist in the brushing and baling of fibre produced at the station, and the owners of estates on which external trials are situated have assisted in the work involved in the cutting of these trials.

A. F. NICHOLS,
Agricultural Officer (Sisal).

EXPERIMENTAL WORK IN GENERAL HUSBANDRY

RIFT VALLEY PROVINCE

Experimental work was carried out at the following stations, the altitude and the name of the officer in charge being given in parentheses after each station: (Kitale, 6,000 ft., H. T. Lloyd); Eldoret (7,200 ft., R. J. Spooner); Ol Joro Orok (7,800 ft., J. T. Schouten); Rongai (7,000 ft.), and Marindas (9,300 ft) in Nakuru area (A. Storrar). Many of the trials were conducted in collaboration with specialist officers and are described in their sectional reports. For example, variety trials with cereals, sunflowers and safflower and wheat rate of seeding trials are dealt with in the report of the Senior Plant Breeder.

Grasses and Legumes

A 3 by 3 by 2 factorial experiment was begun in Marindas in which Olsgaard Danish cocksfoot and Kentucky 31 fescue were planted alone or in combination with subterranean clover, lucerne or trefoil, and received applications of 0, 100, or 200 lb. per acre of soda phosphate. The grasses and legumes were each sown separately in 3-ft. rows, making 18 in. between rows when both were present, and phosphate was placed in the rows at planting time. The yields from the first three cuts show a marked response to phosphate and yields from mixtures containing cocksfoot are superior to those from fescue mixtures.

In a 6 by 6 Latin square clipping trial at Marindas, comparing four strains of cocksfoot (Olsgaard, S.143, S.37, S.26), Kentucky 31 fescue and *Bromus marginatus*, the Bromus came away much more quickly than the other grasses and gave the highest early yields, while Kentucky fescue was slower, and yielded less than the cocksfoots.

A comparison was made at Marindas of planting a grass and one of three legumes either together in rows 3 ft. apart or with the grass and legume alternately in 17-in. rows. The grass used was Olsgaard cocksfoot which was combined with subterranean clover, Congo white clover or trefoil. Subterranean clover and cocksfoot in the same rows gave much the highest early yields but with the other legumes the method of sowing has so far made little difference.

The following grasses and legumes were planted in alternate rows 18 in. apart in duplicate plots at Rongai, one set of plots being grazed and the other being clipped:—

Brachiaria brizantha and *Dolichos* sp. *ex* Kilima Kiu.
Setaria auria and *Dolichos* sp. *ex* Kilima Kiu.
Panicum maximum and *Dolichos* sp. *ex* Kilima Kiu.
Brachiaria brizantha and *Stylosanthes gracilis.*
Panicum maximum and *Stylosanthes gracilis.*
Cynodon plectostachyum and *Stylosanthes gracilis.*

The mixtures containing *Dolichos* gave much higher yields of cut material than those with *Stylosanthes*, chiefly because of the much greater productivity of the former legume. *Brachiaria* was extremely palatable to cattle and *Setaria* was also taken readily, but *Panicum* was not anything like as palatable. Both legumes were largely left when there was plenty of grass, but thereafter *Dolichos* was eaten in preference to *Stylosanthes* which was hardly touched.

Following upon previous work aiming at finding a high seed-yielding strain of *Dolichos lablab* suitable for combining a variety trial of five varieties was conducted at Rongai. "Brown S.A.O." at 1,125 lb. seed per acre was the highest yielder and being erect with few tendrils, is suitable for combining.

Fodder Crops

In a variety trial with three lupin varieties at Kitale, Sweet Blue Lupin significantly out-yielded Sweet Yellow and the latter was better than Bitter Blue. The best of two canna varieties, in a replicated trial at Kitale, yielded at the rate of approximately 40 tons per acre and contained 4.37 per cent of crude protein.

Treatment of Poorly Drained Land

Wheat was planted in thrice-replicated observation plots at Londiani to compare the effect of mole draining versus nil and phosphate versus nil. Mole draining had little effect on yields but application of phosphate gave a threefold increase. At Ol Joro Orok the ridge and furrow system of vlei land has proved effective for the cultivation of cereals and two experiments, one with wheat and the other with oats were put down to compare applications of double superphosphate of 75, 110, 150 and 220 lb. per acre. No yield increases were obtained from dressings above 75 lb. per acre, but it is possible that the results may have been affected by damage to the crop by beetles. On similar land, drained by means of cut-off drains, lime at rates of 0, 1, 3 and 5 tons per acre was tried, but in the season of application it did not increase the yields.

Effect of Phosphate and Nitrogen on Cereal Crop After Breaking Grass

The effect of time and rate of application of fertilizers on the first wheat crop after breaking the land from veld was tested in a 3 by 3 by 3 factorial trial at Ol Joro Orok in which phosphate was applied at 150, 220 or 330 lb. double superphosphate per acre, and sulphate of ammonia at 0, 150 and 220 per acre. There were three times of application of fertilizer: (*a*) early, soon after ploughing, (*b*) late, just before sowing, and (*c*) half the dressing early and half late. No significant responses were obtained.

Other Work

A test at Elburgon showed that MANA (methyl alpha naphtholeneacetic acid) at 60 or 70 grms. per ton was effective in reducing sprouting and loss of weight in stored potatoes. The use of a Holt bracken breaker controlled bracken under high-altitude and rainfall conditions at Sitoten only if the bracken was broken every two months.

CENTRAL PROVINCE

Introduction

The provincial agricultural policy has been stated and worked out on the recognition that the farming activities of the province are divided by a series of clearly separate ecological circumstances which are diverse enough to require individual farming systems. Each of these systems poses its own problems for investigations. This report is therefore arranged to show the experimental activity in the main ecological zones.

A.—Bracken Zone

Trial 1

Object.—To observe the effects of various manurial treatments on various crops.

Locality.—Fort Hall, Gituamba.

Started.—August, 1951.

Treatments.—

(*a*) Lime at three tons per acre.

(*b*) Double supers at 100 lb. per acre.

(*c*) Control.

(*d*) Muriate of potash at 100 lb. per acre.

(*e*) Compost at ten tons per acre.

(*f*) Field peas.

(*g*) *Bromus marginatus.*

(*h*) Wheat.

(*i*) Established Kikuyu grass.

(*j*) Canadian Wonder Beans.

Design.—Single plots of from 0.06 to 0.03 acre. Non-statistical.

Results.—Compost gave a response on all plots except on the Kikuyu grass which gave no reasonable response to any treatment. The improvement given by the compost was very small, i.e. 4 lb. peas from 0.05 of an acre as opposed to nil from other manurial treatments and 5 lb. beans from 0.03 of an acre, as opposed to no recordable yield from any other plot.

Control gave virtually no germination on any sown plot. Other treatments gave slight and variable improvements over control but not enough to produce measureable yields of wheat, beans or peas.

Trial 2

Object.—To determine the manurial requirements of bracken zone soil.

Locality.—Fort Hall, Gituamba.

Started.—November, 1951.

Treatments.—

(*a*) Composted manure at 97 cwt./A *v.* 49 cwt./A.V.O.

(*b*) Sulphate of ammonia at 3 cwt./A *v.* muriate of potash at 1 cwt./A.V.O.

(*c*) Lime at 2 cwt./A *v.* 30 cwt./A.V.O.

Design.—Holmes micro plot layout of 81 plots.

Results.—The report of the Imperial Chemical Industries officer who designed and analysed the experiment states that no significant difference was achieved and that the results were unsatisfactory due to the poor germination on a number of plots.

Trial 3

Object.—To determine a suitable pasture grass for the area.

Locality.—Embu, Kianjokoma.

Started.—1950.

Treatments.—

(*a*) Control Kikuyu grass.

(*b*) Rhodes grass and lucerne.

(*c*) *Bromus marginatus* and lucerne.

(*d*) *Bromus marginatus* alone.

Design.—One paddock of each. Non-statistical.

Results.—Kikuyu grass superior to anything else. Rhodes grass has persisted better than the *Bromus* which completely dried out after good establishment and growth in 1950. Lucerne has also dried out.

Trial 4

Object.—To find a suitable coffee variety for the area.

Locality.—Embu, Kianjokoma.

Started.—1950.

Treatments.—Five varieties:

(*a*) Kents.

(*b*) M.38.

(*c*) N.197.

(*d*) Kenya selected.

(*e*) R.15.

Design.—5 by 5 Latin square. Single plant plots.

Results.—The trial is fully established but growth is slow.

Trial 7

Object.—To find a deciduous fruit cash crop for bracken areas.

Locality.—Embu, Kianjokoma; Fort Hall and Gituamba.

Species.—Between the two places there are various varieties of apples, pears, plums, peaches and cherries.

Design.—Two or three trees of each variety were planted. Non-statistical.

Results.—Peaches at both places have made good growth and cherries are also doing well at Gituamba. Other species are only progressing very slowly.

Observations on Various Species Planted at Kianjokoma and Gituamba

Pyrethrum plantings failed at Kianjokoma and have made only poor growth at Gituamba.

Passion fruit is growing and bearing well at Kianjokoma.

Linseed planted in the long rains at Gituamba grew well but did not mature before the onset of the Gathano.

Napier grass at Gituamba is growing well.

B.—Kikuyu Grass Zone

Trial 1

Object.—Exploratory experiment on the value of artificial fertilizer for increasing maize production in the Kiambu Reserve.

Locality.—Senior Chief Waruhiu's farm, 6,100 ft.

Started.—April, 1951.

Treatments.—

(*a*) Sulphate of ammonia at 106½ lb. per acre.

(*b*) Triple supers at 107½ lb. per acre.

(*c*) Treatment (*a*) + (*b*).

(*d*) Nil, control.

Design.—Randomized blocks of 80 plots of 135/A each. Statistical.

Results.—The phosphate treatment gave a significant treatment at the 0.1 level.

Remarks.—The land had been cultivated for many years and had in the past been heavily dunged.

Trial 2

Object.—As for Trial 1 above.

Locality.—Wangutu Waweru's farm, 5,500 ft.

Started.—April, 1951.

Treatments.—As for 1 above.

Design.—Randomized blocks of 8 plots of 1/80A each.

Results.—No significant differences found.

Remarks.—This land was also heavily dunged in previous years.

Trial 6

Object.—To find a suitable coffee variety for the area around Ngelani.

Locality.—Ngelani.

Results.—A good flowering was obtained in the short rains. Trees continue to grow.

C.—Star Grass Zone

Trial 1

Object.—To find out the most promising of a collection of Cassava varieties from Amani.

Locality.—Embu School Farm.

Started.—December, 1951.

Treatments.—The work on these varieties is split into three parts. First multiplication; second, testing of resistance to disease, particularly Mosaic and Brown streak; and thirdly, yield trial. In addition, tests on palatability are made.

Progress to date.—Twenty-five varieties have been roughly tested for Mosaic resistance by planting a few diseased plants among the original cuttings. Two plants of one variety have shown susceptibility. Multiplication of most varieties has started. Palatability tests have been carried out and none has been found to be bitter.

Trial 7

Object.—To obtain a comparison of yields when Cassava is planted on ridges versus flat and at different spacings.

Locality.—Embu School Farm.

Started.—October, 1951.

Treatments.—

(*a*) Ridge *v.* flat.

(*b*) 4 ft. by 4 ft. *v.* 6 ft. by 6 ft.

Design.—Randomized blocks of four plots combining the above treatments

Results.—Trial satisfactorily established.

Trial 8

Object.—To compare five coffee varieties under local conditions.

Locality.—Embu School Farm.

Started.—9th November, 1950.

Varieties.—Kents. S.L.28. S.L.34. S.L.14. W.192.

Design.—5 by 5 Latin square, each plot having nine plants of a single variety.

Results.—Establishment is not entirely satisfactory and some replacements have still to be made in the long rains 1952.

Trial 9

Object.—To determine the most suitable coffee variety for 5,000 ft. in Embu District.

Locality.—Runyenjis.

Started.—1950.

Varieties.—Kents. Kenya selected. N.39. S.L.30. M.6.

Design.—5 by 5 Latin square with single plant plots.

Results.—Successfully established.

Trial 10

Object.—To try the effects of various treatments on the carrying capacity of useless bush dominated by *Cymbopogon gigantes,* occurring between 4,300 and 5,000 ft. in Embu District.

Locality.—Baricho. Kinyori. Kianyaga.

Started.—1950.

Treatments.—

(*a*) Rotational grazing alone.

(*b*) Removal of inedible material followed by rotational grazing.

(*c*) As (*b*) but with an application of ten tons/A of *boma* manure.

(*d*) Cultivate and plant Star grass.

(*e*) As (*d*) but with an application of ten tons/A of *boma* manure.

Design.—One block of each treatment gives a single block. One block at each of the three sites. Non-statistical.

Results.—

TABLE I—GRAZING DAYS

Treatment	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)
Baricho	88	144	645	1,230	864*
Kinyori	380	790	979	1,461	1,554
Kianyaga	382	366	651	361	854
MEAN	250	433	825	1,114	1,091

* About ten tons of green material was cut in August for silage and haymaking

Remarks.—The Kinyori figures are high, probably due to the fact that the cattle are brought from a distance and spend a short day only on the plots. The Agricultural Officer, Embu, states that the figures for (*a*) are unfairly high since the cattle spend most of their time hunting for food not eating it as in (*d*) and (*e*). At Baricho, eight to nine cattle were kept for the whole year on little over 5 acres from $1\frac{3}{4}$ acres of which 10 tons of green material was cut.

The Agricultural Officer, Embu, considers that the results for the last three months (shown in Table II) give a better relative idea of the value of the various treatments, since the unmanured Star grass plots have now caught up with the manured ones.

TABLE II

Treatments	(a)	(b)	(c)	(d)	(e)
Baricho	20	4	84	513	252*
Kinyori	68	178	163	267	282
Kianyaga	91	120	207	241	514
MEAN	60	113	151	340	349

* Following the silage cut on this plot there has been a lack of quick regrowth.

TABLE III—CARRYING CAPACITY OVER THE WHOLE YEAR

Treatments.—

(*a*) = 0.68 beasts per acre per annum.

(*b*) = 1.2 beasts per acre per annum.

(*c*) = 2.25 beasts per acre per annum.

(*d*) = 3.05 beasts per acre per annum.

(*e*) = 3.6 beasts per acre per annum.

This includes ten tons silage taken as equivalent to 740 cattle days.

Remarks.—The results of this experiment are given in some detail because it is considered that in spite of the non-statistical layout it has clearly shown the benefit of clearing and planting grass on steep slopes in this area of Embu District and in similar areas elsewhere in the province.

GENERAL OBSERVATION PLOTS

The following species were under observation:—

Seradella.—Long rains planting at Fort Hall Seed Farm failed to germinate. Long rains planting there and at Embu School gave poor germination but the plants grew on satisfactorily.

Loofahs, Musa Ensete, Urena Lobata and Spanish and Common Brooms were planted at Embu School and are growing. Seed is being taken for use in further trials if required. A collection of local bean and castor oil varieties from Kitui are being multiplied at Embu.

D.—GRASS—WOODLAND SAVANNAH

Trial 1

Object.—To determine the effect of various burning treatments on the natural herbage at the upper fringe of this zone.

Locality.—Embu District. Mbuti wa Kathiga.

Started.—1946.

Treatments.—As shown in table below.

Design.—Treatments in unreplicated single plots. Non-statistical.

Results.—The analysis of herbage was done from two standpoints. The effects of treatments (*a*) on the amount of inedible material or useless bush; (*b*) the value of the grazing in percentage of potentially valuable grasses.

RESULT OF SAMPLING OF THE GRASS BURNING EXPERIMENT ON CLOSING IN AUGUST, 1951

Treatment	Plot 1		Plot 2		Plot 3		Plot 4		Plot 5		Plot 6		Plot 7		Plot 8	
	Control. Bush untouched.		Burn February every year.		Burn February Alternate years. 1946-48. 1950.		Burn August every year.		Burn August every year.		Burn October every year.		Burn February, Sept., February, Sept., February		Cut July and December every year.	
	Edible	Inedible	Edible	Inedible	Edible	Inedible	Edible	Inedible	Edible	Inedible	Edible	Inedible	Edible	Inedible	Edible	Inedible
Yields samples in lb.—																
1 ..	46	69	61	8	64	24	50	61	73½	19	76	41	98	2	46	1
2 ..	52	48	61	1	69	33	92	11	74	27	101½	3	89	3	57	10
Total ..	98	117	122	9	133	57	142	72	147½	46	177½	44	187	5	103	11
App. Ratio..	1 to 1·2		13·5 to 1		2·3 to 1		2 to 1		3·2 to 1		4 to 1		37·4 to 1		9·4 to 1	
Species Proportion of Grasses.	80 per cent Bush ground cover much the worst.		Small bush only a little more than plot 8. Conspicuously the best.		Bush 4 times as much as plot 7. (¼ plot 4)		Bush 8 times as much as plot 7.		Small bush twice plot 7 in density but comparatively large.		4 times as much small bush as plot 7.		A fair percentage of small bush not shown by weights. A better proportion of edible appears to be 16·1 or less.		No small bush of any size.	
	45% *P. maximum* 20% — 20% *Hyperhennia* spp. 5% Red Oat 10% Other grasses		55% Red Oat 40% *Hyperhennia* 5% Other grasses		35% Red Oat 27½% *Hyperhennia* spp. 12½% *P. max.* 12½% Other grasses including 7½% Sedge		40% Red Oat 27½% *Hyperhennia* 15% *P. max.* 10% — 7½% Other grasses		32½% *Hyperhennia* 32½% *P. max.* 22½% Red Oat 12½% Other grasses		45% *Hyperhennia* 30% Red Oat 12½% *C. gegantea* 2½% Couch 10% Other grasses		45% Red Oat 35% *Hyperhennia* 7½% *P. max.* 5% *C. gegantea* 7½% Other grasses		35% Couch 42½% *P. max.* 5% *C. gegantea* 21% Other grasses mainly Red Oat and *Hyperhennia*	

Conclusions

Under (a) above

(1) Any burning or cutting is better than none.

(2) Burning on alternate years is not enough to keep down bush.

(3) Burning about six weeks before the long rains is better than burning after the long rains have finished or at the onset of the rains.

Under (b) above

The best results from the point of view of good herbage is twice-yearly cutting. Burning in February alone is almost as good as twice-yearly burning in February and July. Frequent cutting eradicates Red Oat grass (or burning encourages it). It is usually a fire-climax species. Frequent cutting does not eradicate *Panicum maximum*.

The Agricultural Officer, Embu District, qualifies the results by saying that it justifies to a point native practice of regular fierce burns, but first, that intensive grazing following the various treatments might have given a different answer and that, secondly, better pasture could have undoubtedly been produced by grubbing the bush and unpalatable grasses.

Trial 2

Object.—To determine good varieties of rice for the Mwea area, in Embu District.

Locality.—Nguka Swamp. *c.* 3,800 ft.

Started.—1949.

Varieties.—Moshi, Shingo la Majani, Sindano, Mbuga, Bungala.

Design.—Five plots. Non-statistical.

Results.—Yield on head unthreshed.

Variety	lb. per acre
Shingo la Majani ..	5,953
Moshi	5,378
Mbuga	7,723
Sindano	7,798
Bungala	11,567

All these yields were obtained by taking the plot area excluding the bunds which would have reduced the yield per acre. The results confirm those of the 1949–50 crop in showing that it is possible to obtain very high yields. Bungala has replaced Sindano as the best variety.

E.—Drier Zones Outside Machakos

Trial 1

Object.—To determine whether there is an advantage in a planted grass ley as opposed to adventitious bush in restoring the fertility of exhausted land.

Locality.—Embu. Siakago Seed Farm. 3,800 ft.

Rainfall.—*c.* 30 to 35 in.

Started.—1948.

Treatments.—

(*a*) Adventitious bush.

(*b*) *Panicum makarikariensis.*

(*c*) *Panicum maximum.*

(*d*) Rhodes grass.

(*e*) *Digitaria swazilandensis.*

(*f*) Molasses grass.

Design.—Four blocks each containing the above treatments unrandomized. Non-statistical.

Results.—Rhodes and *Digitaria* are inferior to the other grasses in growth. *Panicum maximum* looks the best of all. The grass plots will be cultivated for the residual fertility trial in S.R. 1952 or in 1953.

Trial 2

Object.—

(*a*) To compare mixed and single species planting of grain and legumes.

(*b*) To compare manure placed in the rows to manure broadcast.

Locality.—Kabandore Seed Farm. 3,500 ft.

Rainfall.—*Circa* 25 in. per annum.

Started.—Long rains, 1951.

Treatments.—

(*a*) *Mwele* and green gram grown together.

(*b*) *Mwele* and green gram grown apart.

(*c*) Manure put along lines of plants and dug in before sowing.

(*d*) Manure broadcast and dug in.

Design.—Two randomized blocks of four plots each. In each block two plots had mixed sowing and two plots were sown half to gram and half to millet. One block was manured in the drills, on the other the manure was broadcast. Non-statistical.

Results.—Under the conditions of the trial *mwele* appears very definitely to benefit from the companionship of a legume. The *mwele* yield was 83 per cent higher when planted with green gram.

Average yields over the four plots were:—

Treatment.—

(*a*) *Mwele* 20½ lb. Green gram 13¼ lb.

(*b*) *Mwele* 11½ lb. Green gram 12½ lb.

In error, less manure was used when it was put into the rows than when broadcast and therefore no result of any value was obtained on this score.

F.—Experiments Carried Out by the Agricultural Officer (Expts), Machakos

Trial 1

Object.—To compare bulrush millet, maize, Sudan grass and improved Kavirondo sorghum with fertilizer treatments O, N, P, and NP for fodder production.

Locality.—Makabete.

Started.—Short rains, 1950.

Design.—Two 4 by 4 Graeco-Latin square. Statistical.

Results.—Short rains millet, 1950: Yielded slightly higher than others but there was no significant difference between crops.

There were no significant differences between fertilizers but the indications are that the response to phosphate may have been significant but for accidents to two plots.

Trial 2—*Reconditioning Experiment at Makareti*

Object.—To determine the best means of establishing leys on poor eroded soil under low rainfall.

Started.—1949.

Treatments.—Following the initial culture treatments and partial failure to get complete establishment in 1950, efforts were made to do so in 1951. All plots were divided into two and grazing records kept for each sub-plot. Grazing began at the end of April and continued, with a break of five weeks in July and August, until the second week in October.

Results.—During the year, all plots were successfully established and in the period indicated above the following figures for grazing days were obtained.

	Grazing days	Grazing days per acre	Acres per beast
Rhodes grass	1,214	151·7	1·24
Cenchrus and Eragrostis ..	969	121·1	1·56
P. makarikariensis	1,424	178	1·05
Star grass	1,351	168·8	1·11

The figure for acres per beast is based on the total grazing period of 189 days from the end of April to the middle of October; grazing began again in early November, one half of each of the original plots was grazed in the first half of the season and the other half is being grazed in the second half of the season.

Trial 3

Object.—To measure the yields of various maizes brought into Machakos as seed or sample.

Locality.—Masii Seed Farm. 4,400 ft.

Rainfall.—33.21 in. during the experiment.

Started.—23rd March, 1951.

Varieties.—*Nzawi Muratha.* Milton Siding. Yellow Durum. Rongai. Yellow Kitale. S.A.L. Muratha. Yellow Nakuru. Yellow Ulu.

Design.—Statistical.

Results.—No significant differences were obtained. The good rains meant that all varieties produced a crop.

Trial 4

Object.—To make observations on 14 imported varieties of dwarf sorghum in comparison with a local variety.

Localities.—*Masii,* 4,400 ft, 33.21 in. rainfall; Kibwezi, 2,900 ft., 19.12 in. rainfall; Voi, 3,500 ft., 15.83 in. rainfall; Darajani, 2,600 ft., 20.95 in. rainfall.

Results.—Black Kaffir 12, Kaffir 13, Taungs White, Early Hegari and Rodar are the most promising varieties.

Trial 5—*Sorghum Variety Trial*

Object.—To compare yields of more promising types of sorghum tried at Machakos in the short rains, 1950.

Locality.—Machakos, 5,400 ft.

Rainfall.—33.99 in.

Varieties.—Shown below.

Results.—

Variety	Yield in lb./acre
Black Kaffir, 12A ..	290·825
Black Kaffir, 13 ..	174·475
Westland	157·050
Caprock	132·450
Dalhart Wheatland ..	110·525
Taunga White ..	57·250
Matiloko	23·275

Significant difference 147·4 at 5 per cent points.

General.—In addition to the above experiments, 51 local sorghums and 95 sorghums supplied by the Senior Plant Breeder are under observation at Machakos. A number of sorghums are also being bulked for pure seed.

COAST PROVINCE

Crop Varieties and Improvement

Cassava.—The object is to find suitable high-yielding cassava varieties with resistance to mosaic and brown streak, which will be used in the native reserves as a food crop. Good short-term varieties are of some interest for commercial production. The locality of the experiment is Matuga Experimental Station. Observations are also being made on the varieties being grown at Gombato Estate. The trials commenced in 1949 when the first ordinary cassava varieties and hybrid clones were received from the East African Agriculture and Forestry Research Organization, Amani. Cuttings of 40 clones of both ordinary and hybrid cassava, all received from Amani, have been planted at Matuga for eventual full-scale yield, maturity, disease-resistance trials. Only a few cuttings of each variety were received and multiplication has been necessary. This is the stage reached at present. Preliminary observations have been made on a plant-to-plant basis for mosaic; yields of individual plants have been noted at 6, 9, 12, 15 and 21 months for most clones and some very general indications of yielding potential obtained; again notes have been taken on incidence of brown streak on any plants so far lifted but not sufficient data is yet available for a classification with regard to resistance to this disease. Observations have also been taken on the general habit of the clones.

Gombato Estate.—At present, observations on a plant-to-plant basis for incidence of mosaic are being taken on plots of approximately 500 plants each of these varieties planted at Gombato Estate. Other observations will be taken and data obtained from these plots in the coming year.

Cotton.—Preliminary trials with 13 varieties.

The object of the trial is to observe the reactions of a collection of cotton varieties to coastal conditions and to gather some preliminary yield data to serve as a guide to the laying down of statistical trials with the more promising varieties. The trials were started in May, 1951, and have been replicated at three centres, Matuga, Gedi and Kibarani. Thirteen varieties have been planted in adjacent observation plots of approximately 1/20th acre, at each centre. The varieties are as follows:—

1. A. 2106
2. U/0268
3. U4/6250
4. U4/5143
5. UK 48
6. S 47
7. BP52 (3MB)
8. A. 449
9. A. 294
10. A. 618
11. A. 619
12. A. 616
13. A. 5805

Two plots of local cotton were included. The trials have not yet been completed.

Sorghum.—A number of varieties, chiefly semi-dwarf types from America, were grown in observation plots at Matuga. The requirement of the coast is a relatively short-term, high-yielding variety, resistant to disease, palatable and with good storage qualities. The plots were planted rather late, suffered from drought and stalk borer damage and gave low yields, ranging from 30 lb. to 190 lb. per acre. A number of varieties are worth further trial.

Other Crops.—Observation plots were planted with *Urena lobata* Spanish brooms, none of which appeared promising, and with three varieties of castor, all of which are worth further trial. In order to study the behaviour of various species of coffee, plots of *Coffea arabica, C. robusta, C. liberica, C. excelsa,* and *C. stenophylla* have been established. Several short-term maize varieties were grown in observation plots.

Fertilizers and Manures

Factorial fertilizer trials with simple superphosphate, triple superphosphate, soda phosphate and sulphate of ammonia, at 0, 1 and 2 levels of application, were put down at Matuga, Kibarani and Gedi. Two of the trials were failures and at Kibarani no responses were obtained.

A long-term experiment was begun at Kibarani in 1946 to compare no phosphate, 100 and 200 lb. per acre of soda phosphate and 100 and 200 lb. per acre of Uganda rock phosphate, the five treatments to be replicated six times in randomized blocks. Fertilizers were applied to maize in 1946, to sorghum in 1949, and to cassava in 1950. No responses were obtained with these crops nor any residual responses on intermediate crops of groundnuts, molasses grass and maize.

NYANZA PROVINCE

Grass.—Work on grass species and the establishment and management of ley grasses, which is considered to be the most important aspect of investigational work, because of its close relationship to fertility maintenance and land use, could not receive the attention it deserved. The only two experimental farms, namely Kakamega and Kisii, where this work could be done were not developed sufficiently and the one important experiment on molasses grass establishment at Kakamega was a failure owing to phenomenally wet weather. Nevertheless, the observational trials described below and sundry observations made during the year have served to consolidate ideas on the worth of species and on establishment and management problems.

Observational Trial on the Grazing of Molasses Grass at Kakamega Farm.—Four fenced one-acre paddocks in a field sown with molasses grass and well established, were subjected to the following grazing treatments:—

A.—1 beast per acre: ratio grazing to resting 1:1. 2 beasts per paddock.
B.—1.3 beasts per acre: ratio grazing to resting 1:2. 4 beasts per paddock.
C.—1.5 beasts per acre: ratio grazing to resting 1:3. 6 beasts per paddock.
D.—1.6 beasts per acre: ratio grazing to resting 1:4. 8 beasts per paddock.

The beasts were removed from the paddock when it was considered it had been grazed to a judicious level. At the end of the year the number of days on which the four paddocks had been grazed with their respective number of beasts since 27th March, 1951, when the grazing treatments started, was: A:144; B:116; C:81; D:65. These figures, converted to cattle grazing days divided by the predetermined grazing rates per acre and corrected for the fact that grazing periods did not end on 31st December exactly, give the following direct comparisons, showing that varying concentrations of stock and varying ratios of rest period to grazing may have an effect on the carrying capacity of the grass: A:283.5;

B: 367.3; C: 326.7; D: 327.4. Observations of the grass cover resulting from the different concentrations of beasts and the varying ratios of resting period seem to indicate that treatments C and D are not suppressing Star grass and couch grass so effectively as A and B. Treatments A and B seem to maintain the best bottom to the molasses grass and leave no undesirable stalky material as is sometimes the case with treatments C and D. It is not possible to draw any exact conclusion from this experiment but it would appear that management should be based on a 2–3-month rest in good growing weather, after a period of grazing, when the sward is not grazed lower than 6 in. A lower concentration of stock seems to create and maintain a desirable matted bottom, whereas it is considered that a high concentration might damage the grass.

Grazing Capacity of Molasses Grass, Rhodes Grass, and Paspalum dilatatum. (*At Bukura Farm Institute.*).—Three conveniently situated fields, well established under these three grasses, were grazed in what was thought to be the optimum way.

Molasses grass carried: 1.15 head per acre (over a period of one calendar year).

Rhodes grass carried: 2.74 head per acre (over a period of one calendar year).

Paspalum dilatatum carried: 1.41 head per acre (over a period of one calendar year).

In the molasses grass field, the cattle had first been taken out in order to rest the grass. In the *Paspalum dilatatum* field, there was a good bite for the stock, which would increase the head-per-acre figure slightly. In the Rhodes grass field there was not enough grass to affect the head-per-acre figure greatly. Molasses grass was about 70 per cent pure, the *Paspalum* nearly 100 per cent pure and the Rhodes only 40 per cent pure, with a serious encroachment of *Sporobolus* sp.

Palatability Trial with Eight Grasses. (*At Bukura Farm Institute.*)—This trial, originally to observe the establishment of the grasses under maize, was used for judging palatability.

Grazing of the experiment was started in April and the undermentioned periods of grazing were carried out during the year:—

1. April, five days, ten animals.
2. 11th–20th June, ten days, eight animals.
3. 3rd–14th September, twelve days, ten animals.
4. 6th–10th November, five days, ten animals.

Counts were taken of the number of animals grazing on each particular plot of grass at two-hourly intervals between 08.00 hours and 18.00 hours on each grazing day, and the following table is a summary of the counts:—

	Period 1	Period 2	Period 3	Period 4	Total
Paspalum notatum ..	42	69	79	26	216
Paspalum dilatatum ..	33	69	69	67	238
Panicum makarakariensis	34	54	79	14	181
Melinis minutiflora .. molasses grass.	49	0	73	12	134
Brachiaria decumbens ..	30	66	89	15	200
Chloris gayana (Rhodes)	53	82	75	28	238
Mixed indigenous natural cover .. .	34	90	87	31	247
Stenataphrum dimidiatum (Pemba grass) ..	25	50	169	107	351

In periods 1 and 2 it is notable that the animals did not show the marked preference for Pemba grass that they did in periods 3 and 4. The lack of interest in molasses grass is probably related to the fact that animals take some time to get used to its distinctive smell. In period 3, the animals concentrated on the Pemba grass at the start. The following is a report by the Assistant Agricultural Officer running the experiment after period 4: "Figures tend to show a greater palatability of Pemba grass and *Paspalum dilatatum* and examination shows heavy grazing. Examination of other patches grazed indicated that the figure for molasses grass and *Brachiaria* should have been higher. *Paspalum notatum* was hardly touched and only records the fact that, being nearest to the gate, the cattle collected there to be let out for watering . . ."

Observations on 13th December, 1951

Molasses grass.—Well grazed down; complete cover.

Panicum makarakariensis.—Clumpy with very little spread over the ground.

Paspalum dilatatum.—A very good cover with a good bottom.

Paspalum notatum.—A good cover but rather a lot of weeds and a few clumps of molasses grass.

Stenataphrum dimidiatum.—A very good cover, obviously well grazed down when stock were last taken out.

Indigenous plot.—Many dicotyledonous weeds, including a lot of Hydrocotile. *Paspalum* is one of the main constituents.

Rhodes grass.—Very poor and many dicotyledonous weeds have crept in.

Hardly better than the indigenous cover.

Brachiaria decumbens.—A complete low cover but much Hydrocotile between.

Rice.—A yield trial with the 11 named varieties known in the province was planted on the newly opened Kano rice plot at Namasaria. The layout was a randomized block with four replications and a plot size of 1/28th acre. All the varieties except Shingo la Mjane, Sokotera and Moshi took about 150 days to mature. The three varieties named above took about 180 days. The yields were:—

Variety	Lb. per acre	Bags (of 160 lb.) per acre
1. Mbuyu	4,853	30·33
2. Ambarikore	4,109	25·68
3. Sindano	3,985	24·90
4. Faya	3,605	22·53
5. Maji Maji	3,520	22·00
6. Bungala	3,212	20·07
7. Moshi	2,070	12·94
8. Ngindimba	1,815	11·34
9. Sokatera	1,730	10·81
10. Shingo la mjane ..	1,312	8·20
11. Senna	1,301	8·13
Average		17·90 (approx. 1¼ tons)

Variety 1 gave a significantly greater yield than varieties 6–11, but there was no significant difference between varieties 1–5. There was no significant difference between varieties 2–6.

Wheat.—Work on wheat as a crop for Africans was carried out in Kericho (African areas) on the advice of the Senior Plant Breeder. The trials were observational and demonstrational and no statistical layouts were used. The objects of the trial were—

(*a*) to demonstrate that the minimum seed requirement per acre was 100 lb;

(*b*) to demostrate that a clean seed bed was required prior to sowing;

(*c*) to test varieties on a small scale; and

(*d*) to test varieties on a large scale.

(*a*) and (*b*) were demonstrated in four plots at the four centres where the demonstrations were carried out. (*c*) consisted of 1/40th-acre plots sown with the varieties being tested and given below. The four treatments and yields at each centre, at which seed-rate and clean seed bed demonstrations were made, were:—

Treatments	Upper Belgut (Kapsamonget)	Buret (Kapkatet)	Sot. (Sigor)	Sot. (Longisa)
	lb. per acre	*lb. per acre*	*lb. per acre*	
Clean seed bed 100 lb. per acre	556	147·5	362	damaged by cattle and abandoned
Clean seed bed 40 lb. per acre	314	100	278	
Dirty seed bed 100 lb. per acre	480	60	278	
Dirty seed bed 40 lb. per acre	266	100	193	

It was a poor year for wheat owing to heavy rains; yields were so low at Kapkatet and Sigor that the demonstrations were hardly effective. The small-scale variety tests suffered also from a bad wheat year. The following are yields at the four centres:—

Variety	Belgut (Kapsamonget)	Buret (Kapkatet)	Sot. (Sigor)	Sot. (Longisa)
	lb. per acre	*lb. per acre*	*lb. per acre*	
Sabanero ..	1,760	220	880	damaged by cattle and abandoned
294 B	1,120	320	860	
117 A	1,040	120	680	
291	1,040	760	870	
D.C. X Ceres ..	1,040	120	800	
294 M	760	400	880	
184	720	340	—	
Regent	720	80	520	
360 H	720	80	840	
Kenya Governor	560	220	800	
Kenya Settler ..	400	140	780	

Sabanero was easily the best at Kapsamonget and was in the van at Sigor. Its awned habit was a protection against birds that did some damage at Kapsamonget. 360H and Kenya Governor were slightly affected by stem rust at Kapsamonget. The large-scale variety tests were damaged by livestock and suffered from lack of supervision owing to impassable roads in a phenomenally wet year. Sabanero did well against 294M, 291, 360H and 294B. It is favoured by the Kipsigis.

Sugar

Maintenance of Collection of Varieties.—The following varieties were added to the collection: N.CO.79, N.CO.291, N.CO.330, B.3215, B.3439, B.4362, B.37161, B.37193, B.41211, B.41227. Varieties previously collected are given on page 80 of the 1950 annual report.

Varietal Experiments

Latin Square on Miwani Estate.—Varieties: CO.419, CO.421, CO.421 (Miwani Estate seed), CO.281 and MF.2/40. The CO.421 (Miwani Estate seed) appears identical with the seed from the Kibos nursery. It is notable that this variety has not lodged at all and has not suffered to the same extent as the other varieties from white ant damage. MF.2/40 lodged very badly; CO.281 was a little better and CO.419 had about 50 per cent lodged cane. MF.2/40 was the tallest cane, with CO.419 nearly equal. CO.421 was not far behind (8–9 ft.) and CO.281 was the shortest (7–8 ft.). CO.419 had the thickest cane, followed by CO.421, MF.2/40 and CO.281. All the canes had strong stools, with CO.419 slightly in the lead. The weed control by CO.421 was superior. Varieties which lodged were letting in weeds. The experiment is due for harvesting soon and observation indicates that CO.419 may lead slightly over CO.421 but that the latter has many favourable characteristics, the main being absence of lodging, good weed suppression and resistance to white ants, which may be related to the absence of lodging and the fact that it is a harder cane than the other varieties. These observations show that the estate is not going far wrong in bulking CO.421 as a first replacement of CO.281, the variety at present grown there.

Variety Sorting Trials

Five variety sorting tests are planted in the sugar-growing area and one at Kakamega, near which a native jaggery industry is contemplated. Only one of these trials has reached a stage which makes it possible to judge superior varieties. Varieties worth retaining are: CO.331, CO.285, CO.213, CO.434, CO.408, CO.421, CO.419 and B.3337. Varieties not worth retaining are: POJ.2714, POJ.2747, MF.2/40, B.3257, CO.281, CO.244, CO.213, CO.417.

Spacing Trial

A spacing trial with 4 ft., 5 ft. and 6 ft. between rows, and 3 ft. in a row, carried out on the Miwani Estate at Chemelil, using the variety CO.281, showed no significant differences between yield at the different spacings.

4-ft. spacing: 40.72 tons per acre.
5-ft. spacing: 41.35 tons per acre.
6-ft. spacing: 41.51 tons per acre.

The importance of this result lies in the backing it can give to the recommendation to plant at 6 ft., which is more suited to mechanical cultivation.

Cassava.—The following six varieties of mosaic-resistant cassava were planted on the Kakamega farm, in a randomized block layout, with seven different harvesting dates, allowing a growing period of 12, 18, 24, 30, 36, 42 and 48 months: Binti Minsi, Msitu, 37244.E, F.279, Kru, Aipin Valenca. Each plot consisted

of nine plants at 4-ft. spacing, surrounded by a guard row of the local variety susceptible to mosaic disease. The cuttings have grown reasonably well but there are a number of gaps and poor plants. No harvests have as yet been made. A bad hailstorm did some damage, particularly to the variety Binti Minsi. No variety has as yet shown mosaic disease, although the guard rows are infected.

Coffee.—Coffeee investigation consists of a number of variety trials in the coffee-growing areas of the Highlands division of South Nyanza and on the lower slopes of Mount Elgon in North Nyanza. All the trials are progressing well and were laid down either in 1950 or 1951. It is too early as yet to judge varietal differences.

List of Trials

South Nyanza (Highlands Division)

At Kisii Experimental Farm.—7 by 7 Latin square with nine trees per plot, with a ring of trees of S.L.28 surrounding the experiment. Varieties in trial: Kitale 145, Thorold's S.L.14, Blue Mountain, S.L.28, Kent's and Kenya selected.

At Masacho; Nyakai; Yabe; Kiumbu.—9 by 9 single-tree microplots with a surrounding row of Blue Mountain (the local commercial variety). Varieties in trial: S.L.28, S.L.14, Thorold's, Kenya selected, S.L.34, Kent's, N.100, Mocha, and S.L.3.

North Nyanza (Mount Elgon)

Eight 5 by 5 single-tree microplots using the following varieties either in the plots or surrounding rows:—

S.L.9, S.L.2, S.L.28, S.L.34, Kapretwa Series A, S.L.30, K.7, S.L.39.

Cotton.—The cotton varietal experiments planted in 1950 were completed in March, 1951. Details and the results are given below. Experimental work consisted of:—

(*a*) A series of varietal trials using introduced S.47 and UK.48 seed against local BP.52 and N.17 seed. There were early and late plantings at each centre.

(*b*) Two varietal trials using S.47 and four of its derivatives against BP.52 (local) seed. These trials were carried out at the request of the Uganda Department of Agriculture.

Preliminary variety trials had been conducted in previous seasons to test a wide range of material from Barberton (South Africa), Uganda, and Tanganyika. On the results obtained it was decided that S.47 from Uganda and UK.48 from Tanganyika were the only varieties showing promise of excelling the stocks in current production. These two were therefore tested against the locally grown BP.52 and N.17 in trials designed to compare yields under conditions of early and late planting. The results have, on the whole, confirmed that replacement is worth while. S.47 is now the commercial crop from the Uganda border to the Kano plains and it has been decided to replace N.17 by UK.48 in South Nyanza as soon as seed is available.

Data are summarized in Table A. Yields of varieties significantly superior to the lowest yielding in the trial are printed in heavy type.

Summary of Variety Trial Results.—The results are summarized in Table B. They serve to emphasize, as in the 1949–50 trials, the superior yield obtained from early planting. (In commercial plantings this superiority was lost in the unusually wet 1951–52 season.) The increase amounted to 137 lb. per acre, or about one-third, in North Nyanza, and 250 lb. per acre, or 45 per cent, in Kano and South Nyanza.

Table A—Variety Trial Data—Nyanza, 1950–51

Locality	North Nyanza				Central Nyanza			
	Adungosis		Malakisi		Ahero		Kisiani	
Sowing date	9–6–50	21–7–50	14–6–50	17–7–50	7–6–50	13–6–50	6–6–50	15–7–50
N.17	440	594	624	204	**1,018**	347	**1,035**	707
BP.52	481	547	580	**262**	**1,050**	**541**	929	670
S.47	546	636	597	**253**	864	282	894	745
UK.48	**562**	**739**	**704**	203	924	319	881	817
S.E.	31	38	35	12	45	56	44	42
Uniformity				Poor		Poor		Poor
Growth	Vigorous	Vigorous	Lanky		Good		V.G.	Good
Lygus	Severe	Severe	Severe	V. Severe	Severe, early	Moderate	Moderate	Severe
Aphis						Severe		
Bacterial Blight	Not Severe	Not Severe	Not Severe	Not Severe	Not Severe	Not Seen	Not noticeable	Not Seen
Other causes of loss						Stainers present	Stainers jassid	Jassid
Altitude	4,000 ft.	4,000 ft.	4,500 ft.	4,500 ft.	3,900 ft.	3,900 ft.	3,800 ft.	3,800 ft.
Layout	4×4 L.S.	4×4 L.S.	4×4 L.S.	4×4 L.S.	4×4 L.S.	R/B 3 reps.	4×4 L.S.	4×4 L.S.

Locality	South Nyanza							
	Kendu		Nyangwesso		Kochia		Homa Bay	Rangwe
Sowing date	13–6–50	2–8–50	12–6–50	1–8–50	9–6–50	19–7–50	12–6–50	20–6–50
N.17	1,134	480	321	448	**721**	634	477	263
BP.52	1,235	563	396	570	663	768	473	317
S.47	1,210	546	377	524	546	703	549	255
UK.48	**1,389**	511	423	486	**797**	968	578	345
S.E.	77	39	34	59	33	129	43	34
Uniformity		Poor		Poor Stand		Excellent	Poor	
Growth	Good		Excellent	Good	Good	Good	Poor	Poor
Lygus	Severe	Mild	Severe	Moderate	Severe		Crippling	Moderate
Aphis	Severe	Severe	Severe	Severe	Severe			
Bacterial Blight	Slight	Mild	Mild	Not Seen				
Other causes of loss	Hail	Hippopotamus	Drought	Severe jassid		Bud Shedding	Some Damage	Severe
Altitude	3,700 ft.	3,700 ft.	3,800 ft.	3,800 ft.	3,900 ft.	3,900 ft.	3,800 ft.	4,400 ft.
Layout	R/B 4 reps.	R/B 4 reps.	4×4 L.S.	4×4 L.S.	4×4 L.S.	R/B 3 reps.	4×4 L.S.	R/B 4 reps.

Plot size 1/48·4 acre in all cases.

TABLE B—SUMMARY OF VARIETY TRIAL DATA—NYANZA, 1950–51

VARIETY	NORTH NYANZA		KANO AND S. NYANZA		HOMA AND RANGWE	GRAND MEAN
	Early	Late	Early	Late	Early	
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
N.17 ..	532	399	846	523	370	532
BP.52 ..	531	405	855	622	395	562
S.47 ..	571	444	778	560	402	551
UK.48 ..	633	471	883	620	462	614
MEAN ..	567	430	841	581	407	565

Seed cotton from both North Nyanza and South Nyanza trials was sampled, and ginning out-turns determined on the samples. The out-turns of the four varieties were:—

	North	South	Estimated mean lint yield
			lb.
N.17 ..	31·2	31·3	167
BP.52 ..	30·5	—	171
S.47	31·8	30·8	172
UK.48 ..	33·0	33·3	204

There was no difference between the first three varieties, but UK. 48 gave an overall increase of 20 per cent. Moreover, its behaviour was consistent. Reference to Table A shows that it gave the highest yield in ten of the 16 trials, and was low in only two late-sown trials. The two trials of S.47 and its relatives, carried out at the request of the Uganda Department of Agriculture, were planted at Sio Port and Adungosi's. They were laid out as 5 by 5 Latin square, with plots of 1/66th acre. Data are given in Table C.

TABLE C—SUMMARY OF THE DATA FROM TRIALS OF S.47 RELATIVES

LOCALITY .. .. .. SOWING DATE	Adungosi's 21–7–50	Sio Port 18–7–50
	lb.	*lb.*
BP.52	437	432
S.47	457	541
6317	354	455
6354	473	538
6358	442	525
DS.E	28	50
Lygus	Severe	Not serious
Aphis	—	,,
Bacterial blight	Severe	,,
Other causes of loss	Bollworms	—
Harvesting completed	Mid-February	End of January

Differences in seed cotton yield were not significant

Lygus, blackarm and bollworms, and the bud, flower and boll-shedding they cause, are the problems of cotton in Nyanza and it is felt that breeding and entomological research aimed at countering these afflictions, together with a study of the afflictions themselves, to determine methods of control, are the next steps to be taken. Cotton plants can be grown well in Nyanza, but bolls, buds and flowers are shed in profusion, and the potentiality of any variety is largely masked thereby. With these important objectives in view, cotton experimental work was taken over by Mr. M. S. Hastie, a Cotton Research Officer loaned by the Empire Cotton Growing Corporation. Work carried out by him in the 1951–52 cotton season is described briefly below. At the Kibos station numerous varieties and strains were grown for observation, including strains of UK.48 and Alban blackarm-resistant material, which are now considered to be the best foundations for a variety of cotton suitable for Nyanza conditions. Plant history records were kept to determine exactly the pests and diseases which caused loss of crop. Flower- and boll-shedding records were kept for individual plants. Results show, so far, that the American bollworm (*Heliothis armigera*), in its larval stage, was a major cause of loss of crop and low-grade, stained cotton. This finding is confirmed by observations in the field. Various preliminary cultivation, seed dusting, and variety and strain trials were carried out at the Bungoma and Homa Bay sub-stations and at a few, temporary, cotton trial plots.

Experimental work in the 1951–52 season was necessarily restricted and exploratory, much time having been taken up by the construction and layout of the stations. Much invaluable information was, however, gained, especially on the entomological side, and is summarized below.

American bollworm (*Heliothis armigera*) is a major cause of loss of crop, and staining of cotton.

Bacterial blight (*Xanthomonas malvacearum*) caused severe and crippling damage above the altitude of 4,000 ft.; and became even more severe the higher the altitude. The effect of the blight is enhanced by hail, which falls more frequently at the higher altitudes.

Lygus occurred everywhere, but, like bacterial blight, is more severe at the higher limits of the cotton area.

Jassid was most serious in South Nyanza; the strain UK.48 was found to be highly resistant to it, compared with commercially grown strain N.17.

Stainers (*Disdercus* spp.) were very prevalent throughout the season but damage was not proportional to their incidence.

Spiny bollworm (*Earias biplaga*) and *Helopeltis*, although present, caused very little loss.

The best approach to the control of blackarm (bacterial blight) will probably be through the breeding of a resistant variety. It is hoped that entomologists of the Empire Cotton Growing Corporation and this department will be able to give advice, in the 1952–53 season, on measures most likely to overcome the principal pests, *Lygus* and American bollworm.

G.P.K. 322— —1/53